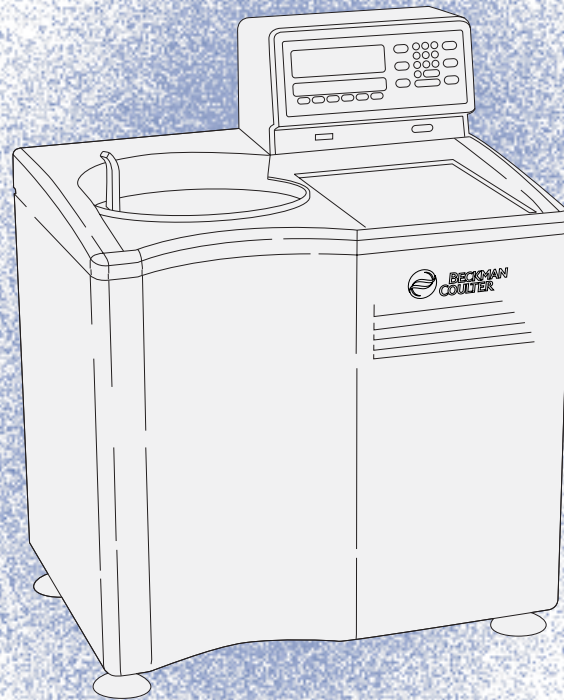


Optima™ LE-80K

Preparative Ultracentrifuge



Instruction Manual

Symbol Symbol Simbolo Símbolo Simbolo 記号	Title / Titel / Titre / Titolo / Titolo / 名称
	Dangerous voltage Gefährliche elektrische Spannung Courant haute tension Voltaje peligroso Pericolo: alta tensione 危険電圧
	Attention, consult accompanying documents Achtung! Begleitpapiere beachten! Attention, consulter les documents joints Atención, consulte los documentos adjuntos Attenzione: consultare le informazioni allegate 注意、添付資料を参照のこと
	On (power) Ein (Netzverbindung) Marche (mise sous tension) Encendido Acceso (sotto tensione) 入 (電源)
	Off (power) Aus (Netzverbindung) Arrêt (mise hors tension) Apagado Spento (fuori tensione) 切 (電源)
	Protective earth (ground) Schutzleiteranschluß Liaison à la terre Puesta a tierra de protección Collegamento di protezione a terra 保護アース (接地)
	Earth (ground) Erde Terre Tierra Scarica a terra アース (接地)



SAFETY NOTICE

This safety notice summarizes information basic to the safe operation of the equipment described in this manual. The international symbol displayed above is a reminder that all safety instructions should be read and understood before installation, operation, maintenance, or repair of this instrument. When you see the symbol on other pages, pay special attention to the safety information presented. Observance of safety precautions will also help to avoid actions that could damage or adversely affect the performance of the equipment.

Other symbols may also be displayed on the equipment. These are reproduced and described on the inside of the front cover.

Safety During Installation and/or Maintenance

This instrument is designed to be installed by a Beckman Coulter Field Service representative. Installation by anyone other than authorized Beckman Coulter personnel invalidates any warranty covering the instrument. Also, if the instrument needs to be moved, a Beckman Coulter Field Service representative must reinstall and relevel the instrument in its new location.

Any servicing of this equipment that requires removal of any covers can expose parts which involve the risk of electric shock or personal injury. Make sure that the power switch is turned off and the instrument is disconnected from the main power source, and refer such servicing to qualified personnel.

Electrical Safety

To reduce the risk of electrical shock, this instrument uses a three-wire electrical cord and plug to connect this equipment to earth-ground. Make sure that the matching wall outlet receptacle is properly wired and earth-grounded.

Do not place containers holding liquid on or near the chamber door. If they spill, liquid may get into the instrument and damage electrical or mechanical components.

Safety Against Risk of Fire

Fuses protect certain electrical circuits within this instrument against overcurrent conditions. For continued protection against the risk of fire, replace only with the same type and rating specified.

This instrument is not designed for use with materials capable of developing flammable or explosive vapors. Do not centrifuge such materials (for example, chloroform or ethyl alcohol) in this instrument nor handle or store them near the centrifuge.

Mechanical Safety

For safe operation of the equipment, observe the following:

- Use only the Beckman Coulter rotors and accessories designed for use in this instrument.
- Do not exceed the maximum rated speed of the rotor in use.
- NEVER attempt to slow or stop a rotor by hand.
- Do not move the centrifuge while the drive motor is spinning.
- In the event of a power failure, do not attempt to retrieve the sample from the instrument for at least one hour. Then follow the instructions for recovery of the sample under TROUBLESHOOTING AND MAINTENANCE.

Chemical and Biological Safety

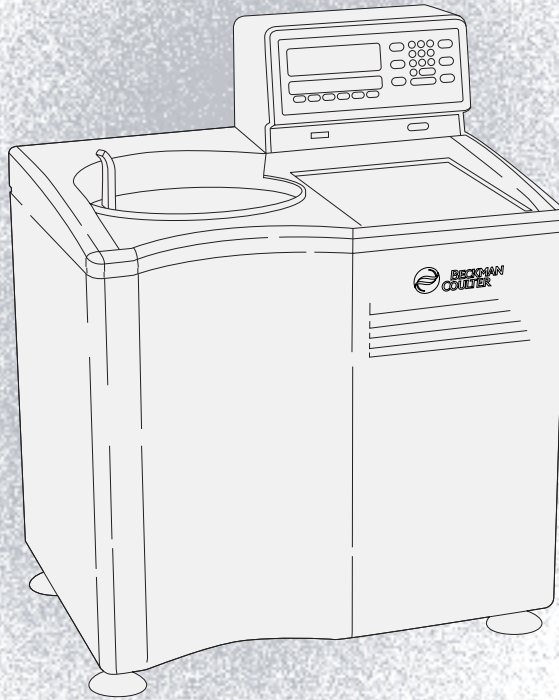
Normal operation may involve the use of solutions and test samples that are pathogenic, toxic, or radioactive. *Such materials should not be used in this instrument, however, unless all necessary safety precautions are taken.*

- Handle body fluids with care because they can transmit disease. No known test offers complete assurance that they are free of micro-organisms. Some of the most virulent—Hepatitis (B and C) and HIV (I–V) viruses, atypical mycobacterium, and certain systemic fungi—further emphasize the need for aerosol protection. Handle other infectious samples according to good laboratory procedures and methods to prevent spread of disease. Because spills may generate aerosols, observe proper safety precautions for aerosol containment. Do not run toxic, pathogenic, or radioactive materials in a rotor without taking appropriate safety precautions. Biosafe containment should be used when Risk Group II materials (as identified in the World Health Organization *Laboratory Biosafety Manual*) are handled; materials of a higher group require more than one level of protection.
- Dispose of all waste solutions according to appropriate environmental health and safety guidelines.

It is your responsibility to decontaminate the instrument and accessories before requesting service by Beckman Coulter Field Service.

Optima™ LE-80K

Preparative Ultracentrifuge



Instruction Manual

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INSTRUMENT CERTIFICATION

To assure full system quality, the Beckman Coulter Optima™ LE-80K ultracentrifuges have been manufactured in an NSAI-registered ISO 9001 facility. They have been designed and tested to meet the laboratory equipment safety standards and regulations (only when used with Beckman Coulter rotors) of CSA and CE Mark.

SCOPE OF THIS MANUAL

This manual is designed to familiarize you with the Beckman Coulter Optima LE-80K Preparative Ultracentrifuge—its functions, specifications, operation, and routine operator care and maintenance.

- The following introductory pages contain the instrument specifications and preinstallation requirements.
- Section 1 provides a brief description of the instrument, the operating controls, and indicators.
- Section 2 explains how to use the control panel to enter run parameters for standard and programmed operation.
- Section 3 covers operating procedures for both kinds of runs.
- Section 4 lists possible malfunctions, together with probable causes and corrective actions, and maintenance procedures.

We recommend that you read this entire manual, especially the SAFETY NOTICE and all safety-related information, before operating or performing maintenance on this instrument.

 **NOTE**

If the Optima LE-80K is used in a manner other than specified in this manual, the safety and performance of this instrument could be impaired. Further, the use of any equipment other than that intended for use by Beckman Coulter has not been evaluated for safety. Use of any equipment not specifically recommended in this manual is the sole responsibility of the user.

CONVENTIONS

NOTES, CAUTIONS, AND WARNINGS

Certain symbols are used throughout this manual to call attention to safety-related and other important information. The symbols used and their definitions are as follows:

 **NOTE**

Used to call attention to information that should be followed during installation, use, and/or servicing of the equipment.

 **CAUTION**

Used to indicate a potentially hazardous situation which, if not avoided, may result in minor or moderate injury and/or mechanical damage. It is also used to alert against unsafe practices.

 **WARNING**

Used whenever an action or condition may potentially cause serious personal injury or loss of life. Mechanical damage may also result.

**WARNING**

Indicates high voltage or risk of electric shock. Refer servicing of all areas displaying this symbol to service personnel.

TYPOGRAPHIC CONVENTIONS

Certain typographic conventions are used throughout this manual to distinguish names of user interface components, such as keys and displays.

- *Key names* (for example, **START** or **ENTER/RECALL**) appear in capital letters within boxes.
- *Display names* (for example, **TEMP°C** or **SPEED-RPM**) appear in bold type.

RADIO INTERFERENCE

This instrument has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with this instruction manual, may cause interference to radio communications. Operation of this equipment in a residential area may cause interference, in which case the user will be required to correct the interference at his or her own expense.

CANADIAN REGULATIONS

This digital apparatus does not exceed the Class A limits for radio noise emissions from digital apparatus as set out in the radio interference regulations of the Canadian Department of Communications.

Le présent appareil numérique n'émet pas de bruits radioélectriques dépassant les limites applicables aux appareils numériques de Classe A prescrites dans le règlement sur le brouillage radioélectrique édicté par le Ministère des Communications du Canada.



SPECIFICATIONS

Only values with tolerances or limits are guaranteed data. Values without tolerances are informative data, without performance guarantee.

CONTROL FEATURES

Speed

Set speed	1000 rpm to 80 000 rpm in increments of 100 rpm
Speed control	actual rotor speed will be ± 50 rpm of the set speed (above 1000 rpm)
Speed display	indicates rotor speed in increments of 10 rpm at speeds below 1000 rpm, and increments of 100 rpm at speed above 1000 rpm

Time

Set time	up to 99 hours and 59 minutes; HOLD for runs of unspecified length
Time display	indicates time remaining in timed runs, time elapsed in HOLD runs, or estimated time remaining in $\omega^2 t$ runs

Rotor Temperature

Set temperature	0 to 40°C in increments of 1°C
Temperature control	$\pm 1^\circ\text{C}$ of set temperature
Temperature display	indicates rotor temperature in increments of 0.1°C
Temperature stability	within 0.3°C of set after equilibrium is reached

ω^2t Integrator

- Set ω^2t up to 9.99×10^{14} radians squared per second
- ω^2t display shows accumulated centrifugal force to three significant digits (in exponential notation)

Acceleration selection from two profiles: maximum acceleration from 0 rpm to set speed, or slow acceleration from 0 to 500 rpm, followed by maximum acceleration to set speed

Deceleration selection from three profiles: full dynamic braking to 0 rpm, slow (full brake to 500 rpm followed by reduced braking to a gentle stop), or no brake

Operation standard, programmed, or delayed start; instrument memory can store up to nine individual programs

OPERATIONAL FEATURES

Revolution Counter displays accumulated total number of rotor revolutions in tens of thousands

Barrier Ring 41-mm (1.63-in.) heat-treated steel alloy armor ring surrounded by a 12-mm (0.50-in.) steel vacuum chamber to provide full protection for the operator

Door 17.5-mm (0.69-in.) high-strength structural steel

Vacuum diffusion pump in series with a mechanical pump reduces chamber pressure to below 5 microns (0.7 Pa)

Instrument Classification R (uses all Beckman Coulter preparative rotors except Types 35 and 42.1 rotors with serial numbers 1299 or lower); not equipped for zonal or continuous-flow operation

INSTALLATION REQUIREMENTS



CAUTION

Do not attempt to install or turn on the power to the instrument. Its purchase price includes installation by Beckman Coulter Field Service. Installation by anyone other than authorized Beckman Coulter personnel invalidates the warranty.

PREINSTALLATION REQUIREMENTS

Preinstallation requirements have been sent prior to shipment of the instrument. (Copies are also attached to the shipping container.) The following information is provided in case the ultracentrifuge must be relocated. Contact your Beckman Coulter Field Service representative to adjust and level the instrument if it must be moved. (The pads on each leveling leg are designed to prevent possible rotation of the instrument in case of a rotor mishap.)

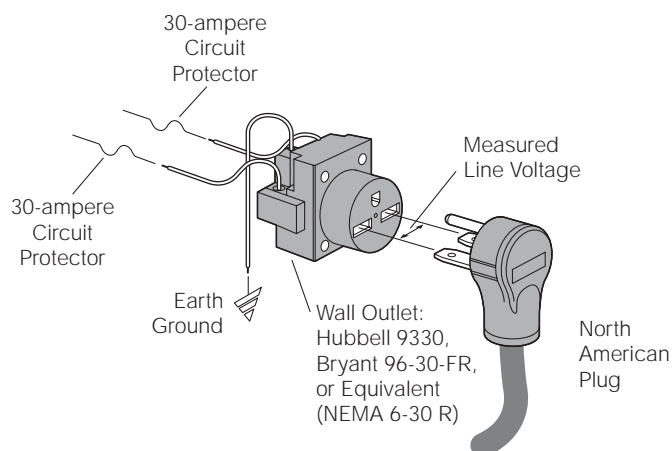
Electrical Data

Instrument rating: 220 to 240 VAC, 50 Hz, 20 A



200 to 240 VAC, 50/60 Hz, 20 A

Power line range: 180 to 264 VAC, 60 or 50 Hz (single-phase), 30 A

To reduce the risk of electrical shock, this equipment uses a three-wire electrical cord (1.8 m; 6 ft) and plug to connect the equipment to earthground. In regions where the instrument is supplied with an unterminated cord, a plug that meets local electrical and safety requirements must be supplied. (Contact your local Beckman Coulter office for specific information regarding these requirements.) See the Table below for the required wire connections. Make sure that the matching wall outlet receptacle is properly wired and earth-grounded.



Required Wire Connections

Wire Insulation Color	Terminal	Symbol	
		Harmonized	North American
Green/Yellow	Earth ground		
Light Blue	Neutral	N	L
Brown	Live or Line	L	L

To ensure safety, the instrument should be wired to a remote emergency switch (preferably outside the room where the centrifuge is housed, or adjacent to the exit from that room), in order to disconnect the instrument from the main power source in case of a malfunction.

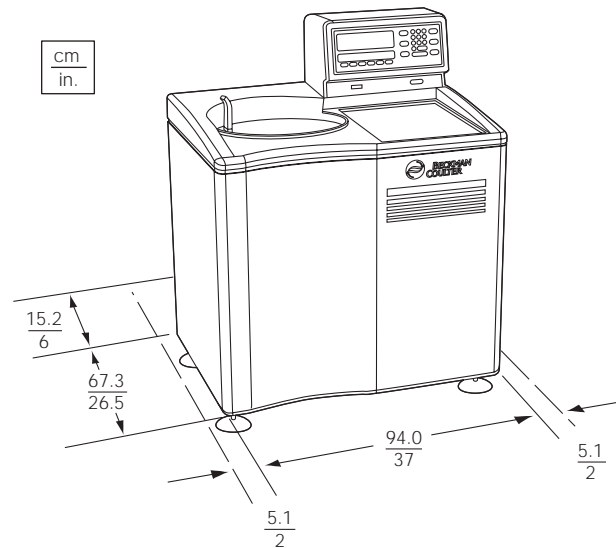
Space

Locate the Optima LE-80K in a clean, safe, uncluttered environment. Be sure to provide a 5.1-cm (2-in.) clearance on each side of the instrument, as the feet extend about 5.1 cm (2 in.) beyond the instrument. (The pads under each foot have been designed to prevent possible rotation of the instrument in the event of a rotor mishap.) A 15.2-cm (6-in.) clearance is required at the rear of the instrument for servicing the control panel and to ensure sufficient air ventilation during operation.

The instrument will operate within specifications in a laboratory with ambient temperatures ranging from 15 to 40°C.

**WARNING**

Do not place the instrument near areas containing flammable reagents or combustible fluids.



PHYSICAL DATA

Weight	465 kg (1025 lb)
Height (overall)	120.7 cm (47.5 in.)
Width	94.0 cm (37 in.)
Depth	67.3 cm (26.5 in.)
Clearances	5.1 cm (2 in.) sides; 15.2 cm (6 in.) rear
Finish	urethane paint on top surface; general-purpose paint on other surfaces; coated polycarbonate finish on control panel
Maximum heat dissipation into the room	1.0 kW (3400 Btu/hr)
Humidity restrictions	<95% (non-condensing)
Noise level measured 0.91 m (3 ft) in front of the instrument57 dBa
Installation category	II
Pollution degree	2



This section describes major instrument components.

POWER

A circuit breaker, labeled I (on) and O (off), is located on the right side of the instrument and controls electrical power to the instrument. Power may be left ON at all times (see STANDBY MODE below) except in the case of an emergency or when maintenance is required.

A red POWER OFF button is provided on the neck of the control head for your convenience (see Figure 1-1). Pressing the POWER OFF button trips the circuit breaker to the off position. To return power to the instrument, the circuit breaker *must* be returned to the up position.

STANDBY MODE

When the instrument is at rest, it automatically goes into standby mode. In this condition, only minimal power is used by the instrument. To restore the instrument to fully operational mode, press any key.

CONTROL PANEL

Figure 1-1 shows the Optima LE-80K control panel, which includes a video display and keys for entering run information.

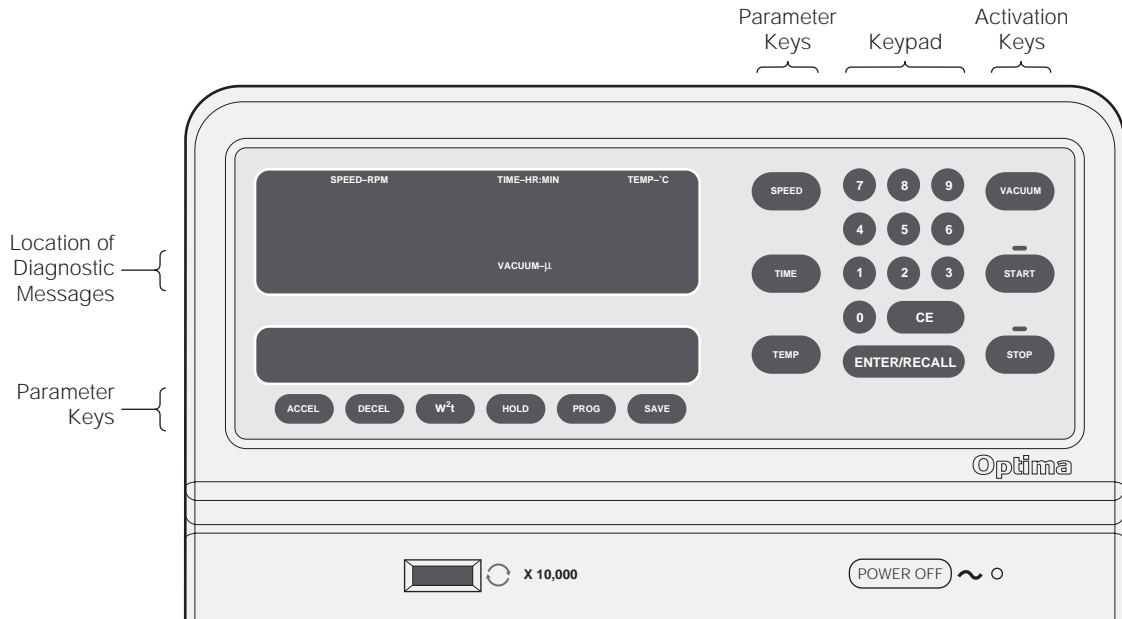


Figure 1-1. The Control Panel

HARDKEYS

- Parameter hardkeys are used to enter the run conditions. They are (SPEED), (TIME), and (TEMP) to the left of the keypad and (ACCEL), (DECEL), (ω^2t), (HOLD), (PROG), and (SAVE) along the bottom of the display area.
- Activation keys control specific ultracentrifuge functions. These are (VACUUM), (START) and (STOP), located to the right of the keypad.

The keypad is used to enter numerical values. It consists of the numbers 0 through 9, a (CE) (clear entry) key, and an (ENTER/RECALL) key.

DISPLAYS

Digital displays indicate rotor speed, run time, rotor temperature, the ω^2t value (when in that mode), and the selected program number (if used). The displays serve a dual purpose.

Actual (Current) Values

When the power is on, the displays show actual operating conditions at all times except when the instrument is in editing mode or when **(ENTER/RECALL)** has been pressed (see below).

Set Values

Set values are the run conditions entered by the user. When you press a parameter key, the associated display blinks to indicate that a value can be entered or modified. This is referred to as the “editing” mode.

The display continues to blink until you press another parameter key or **(ENTER/RECALL)**. If you press another parameter key, the associated display begins to blink and the set values continue to be displayed. If you press **(ENTER/RECALL)**, the instrument displays the set values for 5 seconds, then exits the editing mode and returns to showing actual conditions. Set values remain in memory until new values are entered.

Whenever you press **(ENTER/RECALL)**, the instrument displays the set values for 5 seconds, then returns to showing actual conditions.

RUN STATUS INDICATORS

Run indicators are provided in the form of green and red LEDs to indicate the status of the instrument. Figure 1-1 shows the location of the LEDs on the control panel and Table 1-1 describes the meaning of each. (Unless otherwise noted, the LEDs appear above their respective keys.)

DIAGNOSTIC MESSAGES

Diagnostic messages appear as red LEDs under the **SPEED** display (see Figure 1-1) to alert you to conditions that may need attention. The indicators are not visible unless an abnormal condition occurs.

The meanings of the diagnostic messages, as well as appropriate actions to take, are discussed in Section 4, TROUBLESHOOTING AND MAINTENANCE.

Table 1-1. Run Status Indicators

Key Pressed	Description of Run Status Indicators
START	A green LED on the (START) key lights when the key has been pressed. It blinks until the rotor reaches set speed and then remains lit until the run ends or (STOP) is pressed.
STOP	A green LED on the (STOP) key lights when either the key is pressed or the rotor begins to decelerate. It blinks until the rotor comes to a stop.
ACCEL	"MAX" or "SLOW" indicates which acceleration profile has been selected.
DECEL	"MAX," "SLOW," or "NO BRAKE" indicates which deceleration profile has been selected.
$\omega^2 t$	" $\omega^2 t$ " indicates that the ultracentrifuge is in the $\omega^2 t$ mode.
HOLD	"HOLD" indicates that the ultracentrifuge is in the HOLD mode.
PROG	A number (1 through 9) above the (PROG) (program) key indicates the number of the stored program that has been selected for the run.
SAVE	"SAVE" blinks to indicate that you may save the program values just entered. Press (SAVE) and the values will be saved in memory under the assigned program number.
VACUUM	"750," "200," and "<20" (microns) — located in the upper display — indicate the approximate chamber pressure as the chamber is being evacuated. Only one LED will be on continuously at any given time. Once below 20 microns the "<20" LED shines continuously until the (VACUUM) key is pressed to vent the chamber. (The instrument will typically draw vacuum to 5 microns or less.)

DOOR

The chamber door is made of high-strength structural steel. A solenoid interlock prevents it from being opened during operation. The door can be opened only by using the door handle and only if the power is on and the vacuum is off, with the chamber at atmospheric pressure. Refer to Section 4 for instructions on accessing the chamber to retrieve a sample in case of a power outage.

ROTOR CHAMBER

The rotor chamber is made of aluminum, coated with a chemical-resistant epoxy finish. The rotor drive spindle, radiometer, photoelectric devices, and safety plate are visible in the bottom of the chamber (Figure 1-2).



Figure 1-2. The Rotor Chamber

VACUUM SYSTEM

The vacuum system is automatically activated when **ENTER/RECALL** and **START** are pressed, or it may be turned on directly by pressing the **VACUUM** key. Three vacuum LEDs, labeled 750, 200, and <20, are located in the middle of the upper display to indicate the level of chamber pressure in microns.

At the end of a run, the chamber vacuum must be vented (by pressing **VACUUM**) before the door can be opened. After the door is opened, the chamber is brought to approximate room temperature to prevent condensation from collecting in the chamber. To help keep the chamber dry and clean, the door should be kept closed whenever possible.

A purge system removes significant amounts of moisture from the vacuum pump and chamber. If it takes a long time to pull a vacuum, however, it is likely caused by excess moisture in the system. Refer to Section 4 for information on correcting this condition.

TEMPERATURE SENSING

Rotor temperature is monitored by a radiometer mounted in the bottom of the rotor chamber (see Figure 1-2) when the chamber pressure is below 100 microns. Above 100 microns (or if the radiometer fails), *chamber* temperature is measured by a thermistor mounted in the chamber.

TEMPERATURE CONTROL SYSTEM

The instrument uses a solid-state thermoelectric refrigeration and heating system, which eliminates the need for a conventional refrigeration system and heater. Neither Freon¹ nor water is needed; the only coolant required is forced air from the cooling fans.

After the power is turned on, the temperature control system is activated when the door is closed and the vacuum system is turned on. The rotor temperature is controlled to $\pm 1^{\circ}\text{C}$ of the set value. If the temperature system malfunctions, the **TEMP** diagnostic message will appear and the rotor will decelerate to a stop.

OVERSPEED SYSTEM

The overspeed system is a safety feature designed to ensure that the rotor does not exceed its maximum allowable speed. This system includes photoelectric sensors in the rotor chamber next to the drive spindle (see Figure 1-2) and an overspeed disk on the bottom of the rotor. Individual rotor manuals provide information on the correct overspeed disks to be used with each rotor.

The overspeed disk has alternating light and dark sectors. As the rotor spins, the passage of reflecting and nonreflecting sectors over the photoelectric device generates a series of pulses that are detected by electronic circuitry and processed by the software.

¹ Trademark of E. I. Du Pont de Nemours & Company.

After the rotor reaches 1000 rpm, the set speed is checked against the overspeed disk. If the set speed is greater than the maximum speed permitted by the disk, the speed setting is automatically lowered to the disk's maximum speed, but the run continues without interruption. An error message is displayed to alert you to the change. (In the ω^2t mode, the time setting is recalculated to give an equivalent ω^2t value.)

ROTOR ENERGY SYSTEM

As the rotor accelerates between 15 000 and 21 000 rpm, rotor inertia is measured and the rotor energy is calculated for the set speed. If the calculated rotor energy is determined to be excessive, a **SPEED** diagnostic message will appear and the instrument will immediately shut down, thus providing a redundant safety check.

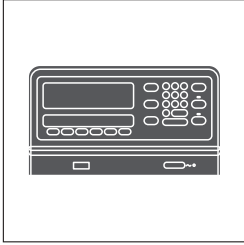
DRIVE

The instrument uses a frequency-controlled, air-cooled, direct-drive induction motor that requires no gears or brushes. In addition, the drive does not require an oil vacuum seal, external oil reservoir, or continuously operating damper.² Externally cooled by forced air and internally cooled by oil, the drive delivers ultra-smooth, quiet performance, with high tolerance of rotor imbalance.

NAME RATING PLATE

A name rating plate is affixed to the rear of the instrument. Always mention the serial number (located on the chamber door) and model number when contacting Beckman Coulter regarding your Optima LE-80K.

² U.S. Pat. No. 4,846,773.



Run Preparation

This section explains how to enter run information.

ENTERING INFORMATION

Entering or modifying information is referred to as being in the *editing mode*.

- Press the appropriate hardkey to enter or modify information or to access a specific function.
- When you press a parameter key, the appropriate field on the screen will begin to blink, indicating that you can enter or modify the value in that field.
- While a field is still blinking, you can retrieve the original value after having modified it by pressing that parameter key again. The original value appears but the field continues to blink so that you can either enter a new value or press **ENTER** to retain the original one.
- Press **ENTER** or another parameter key to save the entry. If the entry is valid the field will stop blinking. If the entry is invalid, the field will continue to blink, an error tone will sound, and a message will be displayed to explain the error. Enter an acceptable value as prompted.

STANDARD OPERATION

KEYPAD

Use the number keys, in sequence, to make numerical entries. As you enter each digit, the digits already entered move one place to the left in the display.

CE (CLEAR ENTRY)

The **CE** key can clear a value after a parameter key has been pressed (if the instrument is in the editing mode), or it can clear a diagnostic message.

- Press **CE** *once* to clear a value while in the editing mode or to clear a diagnostic message.
- Press **CE** a second time to exit from the editing mode. The field will stop blinking and the actual values will reappear.

ENTER/RECALL

- Press **ENTER/RECALL** to enter a setting into memory.
- Press **ENTER/RECALL** and **START** within 5 seconds to start a run.
- Press **ENTER/RECALL** during a run to display the settings for 5 seconds. After 5 seconds, the displays show the actual conditions once again.
- Press **ENTER/RECALL** and **STOP** within 5 seconds to display the STOP values (the values that existed when the rotor began decelerating.)

PARAMETER KEYS

Follow the instructions below for using the parameter keys and keypad to enter run settings.

SPEED

Run speed can be set between 1000 and 80 000 rpm in increments of 100 rpm. Speeds between 0 and 1000 rpm are displayed in increments of 10 (for example, 980 rpm). Speeds above 1000 rpm are displayed in increments of 100 (for example, 45 600 rpm).

A delayed start program function automatically sets the speed at “0” rpm. This function is described at the end of this section.

To enter or modify the set speed:

1. Press **SPEED**. The **SPEED** field blinks.
2. Use the keypad to enter or modify the speed. (The last two digits are fixed as zeros and cannot be changed by keypad entries.) If you try to enter an invalid number—such as 98 000 rpm—the instrument will beep twice. Press **CE** to clear the value, then enter a valid speed.
3. Press another parameter key or **ENTER/RECALL** to save the set speed.

Example: To enter 60 000 rpm as the set speed:

Press **SPEED**.

Press **6**, **0**, **0** in that order.

Press another parameter key or **ENTER/RECALL**.

At 1000 rpm, the set speed is checked against the overspeed disk. If the speed setting is greater than that allowed by the overspeed disk, the run will continue, *but the rotor speed will be lowered to the maximum speed permitted by the disk*. The **TIME** setting is also changed to provide an equivalent $\omega^2 t$ value, if in the $\omega^2 t$ mode. A **SPEED** diagnostic message will appear, indicating that these changes have been made. Press **CE** to clear the message.

You may change the set speed at any time by repeating the steps in the example. The rotor will accelerate or decelerate to the new speed.

The rotor will not accelerate beyond 3000 rpm until chamber pressure drops below 750 microns. At that point, the rotor accelerates to set speed.

If a speed-related malfunction occurs, the **SPEED** diagnostic message will appear on the screen. Consult the Diagnostic Troubleshooting Chart in Section 4 for further details.

TIME

The run termination method depends on the run mode—TIME, ω^2t , or HOLD. The information that appears in the **TIME-HR: MIN** display also depends upon the mode selected.

Run time can be set up to 99 hours and 59 minutes. During the run, the display indicates *the time remaining* in hours and minutes. (When **ENTER/RECALL** is pressed, however, the set time is shown for 5 seconds.)

To enter or modify the TIME setting (in TIME mode):

1. Press **TIME**. The **TIME** field blinks.
2. Use the keypad to enter or modify the run time. As each digit is entered, the previous digit moves one place to the left.
3. Press another parameter key or **ENTER/RECALL** to save the run time.

Example: To enter 16 hours and 30 minutes as the run time:

Press **TIME**.

Press **1**, **6**, **3**, **0** in that order.

Press another parameter key or **ENTER/RECALL**.

If you entered a number that is between 60 and 99 minutes, the instrument automatically recalculates the time in hours and minutes.

Example: If you enter **9** **0** as your run time, the instrument will change the entry to read 1:30.

After you press **ENTER/RECALL** and **START** to begin the run, the instrument checks to make sure that a time entry has been made. (The instrument cannot proceed without a valid entry for TIME, ω^2t , or HOLD.) If you have not made an entry, the TIME field blinks and you must enter one before the run can proceed.

The time begins counting down when the rotor begins to accelerate. When the time remaining reaches zero, the rotor automatically decelerates to a stop.

 ω^2t **(Accumulated Centrifugal Effect)**

The ω^2t display indicates the accumulated centrifugal effect in radians squared per second, to three significant digits, using exponential notation. The ω^2t can be set for up to 9.99×10^{14} radians squared per second. The ω^2t begins accumulating when **ENTER/RECALL** and

(START) have been pressed and the rotor begins spinning; deceleration begins when the set value is reached.

There is no separate ω^2t display—the ω^2t values are shown in the **SPEED** display when the instrument is in the ω^2t mode and the **(ω^2t)** key is pressed.

To enter or modify the ω^2t setting:

1. Press **(ω^2t)**. The **SPEED** field blinks.
2. Use the keypad to enter an ω^2t value. An “E” remains stationary in the hundreds place to indicate that the last two places represent the exponent. If you enter an invalid number, the instrument will beep twice. Press **(CE)** to clear the value, then enter a valid number.
3. Press another parameter key or **(ENTER/RECALL)** to save the ω^2t value. The ω^2t indicator will light.

Example: To enter 3.24×10^{12} as the ω^2t value:

Press **(ω^2t)**.

Press **(3)**, **(2)**, **(4)**, **(1)**, **(2)** in that order. (The display will show “3.24E12.”)

Press another parameter key or **(ENTER/RECALL)**.

When in the ω^2t mode, a calculation of the *time remaining* (until the set ω^2t value is reached) is shown in the **TIME** display. (If the calculation exceeds 99 hours and 59 minutes, four dashes will appear in the **TIME** display.)

After the run, pressing **(ENTER/RECALL)**, **(STOP)**, and **(ω^2t)** in succession will show the accumulated value for ω^2t (in the **SPEED** display) when the rotor began to decelerate. After 5 seconds, the display returns to showing current conditions.

The ω^2t LED will remain on until a different run mode is selected as a reminder that the instrument is still in the ω^2t mode. The accumulated ω^2t from the previous run will automatically return to zero when **(ENTER/RECALL)** and **(START)** are pressed to begin a new run.

(HOLD)

The **HOLD** mode is used for runs of unspecified lengths. When **(ENTER/RECALL)** is pressed while the instrument is in this mode, the word **HOLD** appears in the **TIME** display for 5 seconds. The display then returns to showing the time *elapsed* since the beginning of the run.

To select the HOLD mode:

1. Press **(HOLD)**. The LED above the **(HOLD)** key lights to indicate that the instrument is in HOLD mode, and the word HOLD appears in the **TIME** display.
2. Press the next parameter key or **(ENTER/RECALL)**.

After **(ENTER/RECALL)** and **(START)** have been pressed, the run will continue indefinitely until you press **(STOP)** to end it. If the run exceeds 99 hours and 59 minutes, dashes appear in the **TIME** display.

(TEMP)
(Temperature)

The temperature can be set between 0 and 40°C in increments of 1°C. If no other value has been entered, the instrument automatically selects 25°C as the default value for the operating temperature.

To enter or modify the TEMP setting:

1. Press **(TEMP)**. The **TEMP** field blinks.
2. Use the keypad to enter or modify the temperature setting. If you make an invalid entry, the instrument will beep twice. Press **(CE)** to clear the entry, then enter a valid temperature setting.
3. Press another parameter key or **(ENTER/RECALL)** to save the temperature setting.

Example: To enter 20°C as the run temperature:

Press **(TEMP)**.

Press **(2)**, **(0)** in that order.

Press another parameter key or **(ENTER/RECALL)**.

You may change the set temperature at any time by repeating the steps in the example. The rotor temperature will be adjusted accordingly.

Actual rotor temperature, after equilibration, is controlled to $\pm 1^\circ\text{C}$ of the set value. If the temperature control system malfunctions, the **TEMP** diagnostic message will light and the rotor will decelerate to a stop.

(ACCEL)
(Acceleration)

The instrument has two acceleration profiles: maximum and slow. (The default setting is MAX.) To select slow acceleration, press **(ACCEL)**. The SLOW run status indicator will light. The key acts as a toggle switch; press it again to select MAX acceleration. Each time you press the **(ACCEL)** key, the alternate choice will light.

DECEL
(Deceleration)

The instrument has three deceleration profiles: maximum, slow, and no brake. (The default setting is MAX.) To select slow deceleration, press **DECEL**. The SLOW run status indicator will light. The key acts as a toggle switch; press it again to select NO BRAKE and again to select MAX deceleration. Each time you press the **DECEL** key, the next choice in the series will light.

PROGRAMMED OPERATION

PROG (Program)
and
SAVE

The instrument internal memory is capable of holding up to nine sets of user-specified run conditions, referred to as programs. Each program is stored by number and can be recalled using the keypad. Programs are retained in memory even when the power is turned off.

You can select an existing program by either pressing the program number (1 to 9) using the keypad, or by pressing the **PROG** key repeatedly until the desired set of parameters appears. (This is useful if you do not remember the contents of a particular program or to scan through available programs.)

Follow the instructions below to create a new program or to modify an existing one.

To create or modify a program:

1. Press **PROG**. If no program has been previously selected, a dash will appear above the **PROG** key. Actual values remain in the other displays.
2. Use the keypad to select a program number, which replaces the dash in the display. (Or continue pressing **PROG** until the program number appears.) The program number blinks to indicate that you are editing the program.
3. Use the parameter keys and keypad to enter the run settings. After all parameters have been entered, press **ENTER/RECALL**. The SAVE indicator blinks indicating that you may save the program.
4. Press **SAVE** and the program will be stored in memory under the assigned number. Actual values will reappear in the displays.

To select a program for use:

1. Press **(PROG)**.
2. Press the appropriate program number.
3. Press **(ENTER/RECALL)** and **(START)**.

To modify a parameter during the run without affecting the program, change the setting in the normal manner, then press **(ENTER/RECALL)**. Do NOT press **(SAVE)**. The instrument will run using the modified settings, but the program itself will remain unchanged. The number above the **(PROG)** key will go out to indicate that the instrument is no longer running from program memory.

ACTIVATION KEYS

Use the activation keys to control the following ultracentrifuge functions.

(VACUUM)

The vacuum system is activated automatically when you press **(ENTER/RECALL)** and **(START)** to begin a run. To evacuate the chamber at another time, make sure the chamber door is closed, then press **(VACUUM)**.

As the vacuum system begins to evacuate the chamber, a series of three LEDs (labeled 750, 200, and <20 microns) blink, remain lighted, or go off to allow you to monitor the change in pressure (see Table 2-1). When the pressure drops below 20 microns, the < 20 LED will remain lit until **(VACUUM)** is pressed to vent the chamber at the end of the run.

Table 2-1. Vacuum LEDs

Pressure	750 LED	200 LED	<20 LED
750 or above	blinking	off	off
220 to 750	lit	blinking	off
20 to 200	off	lit	blinking
<20	off	off	lit

When the run begins, the rotor will not accelerate past 3000 rpm until the chamber pressure drops below 750 microns. At that time, the rotor accelerates to set speed.

To vent the chamber, press **VACUUM**. The chamber door can be opened only when the vacuum has been completely vented and the rotor is at rest.

START

Press **ENTER/RECALL** and **START** to begin a run. If you press only **START**, the instrument will not be activated. If this occurs, press **ENTER/RECALL** and **START** again to begin the run.

After you have pressed **ENTER/RECALL** and **START**, the instrument checks for a setting in the **TIME** field. If there is no entry, the instrument beeps twice and the **TIME** display begins blinking. Enter a value and press **ENTER/RECALL**. Then press **ENTER/RECALL** and **START** again to begin the run.

As the rotor begins to accelerate, the green LED on the **START** key begins to blink. When the rotor reaches set speed, the LED stops blinking and remains on until the run ends or **STOP** is pressed.

STOP

Use the **STOP** key to do the following:

- Press **STOP** at any time to terminate the run. A green LED on the key will blink to indicate that the rotor is decelerating; a tone will sound when the rotor comes to a stop and the green LED will turn off.
- Press **ENTER/RECALL** and **STOP** within 5 seconds to display the run conditions that existed when the rotor began decelerating. These are called the STOP values.
- Press **ENTER/RECALL**, **STOP**, and **ω^2t** in succession to display the accumulated ω^2t at the time the rotor began decelerating. The ω^2t value is displayed in the **SPEED** display.

DELAYED START PROGRAM FUNCTION

The delayed start program function allows you to delay the start of a run so that it begins and ends at the time you require—without you being there to start the run. For example, if you require a four-hour run to end at 8:00 am, you can program the instrument to hold the rotor at a specified temperature and time *at zero speed* and then automatically begin the run at 4:00 am.

To use the delayed start program function, a special program (called program “0”) is created, followed by a second program that contains the run conditions for the actual run. Follow the instructions below.

ENTERING PROGRAM 0

The first program —program 0— is used to delay the start of the run until the required time. Enter the settings as follows.

1. Press **(PROG)** then **(0)** on the keypad to access program 0. A blinking zero appears above the **(PROG)** key. The existing settings for program 0 are displayed.
2. Use the parameter keys and keypad to enter time and temperature settings as required. *You cannot change the speed setting, which is set at zero.* (If you try to change it, the instrument will signal an error.)
3. Press **(ENTER/RECALL)**. The SAVE message blinks to indicate that you can save the program settings.
4. Press **(SAVE)** to save program 0.
5. To exit from the program mode, press **(CE)** twice.

RUNNING PROGRAM 0 WITH A SECOND PROGRAM

To run the delayed start program function, do the following.

1. Press **(PROG)** then **(0)** on the keypad to access program 0. A blinking zero appears above the **(PROG)** key, and the display shows the program 0 settings.
2. Use the keypad to select a second program from the stored programs. The selected program settings appear in the display and the program number appears in the **(PROG)** display. Press **(ENTER/RECALL)**.
3. To begin the delayed start program function, press **(ENTER/RECALL)** and **(START)**.

The word “delay” appears in the **SPEED** display and the second program number you selected appears in the **(PROG)** display.

When the elapsed time in program 0 reaches zero, the second program begins automatically.

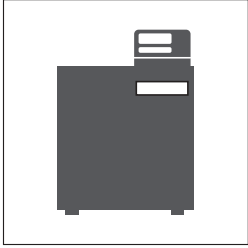
Example: To run programs 0 and 3:

Press **PROG**, **0**, **3**, and **ENTER/RECALL**.

Press **ENTER/RECALL** and **START**.

NOTE

If you change a run setting during program 0, the second program is *automatically canceled*. The instrument will stop at the end of program 0.



Run Procedure

This section summarizes standard and programmed operation as well as the delayed start function. Use any of the acceptable Beckman Coulter rotors, consulting the applicable rotor manual and Rotors and Tubes for Preparative Ultracentrifuges (LR-IM) for instructions on preparing the rotor and accessories for centrifugation. The Optima LE-80K is not equipped for zonal or continuous-flow operation. For fast temperature equilibration, refrigerate or warm the rotor to the required temperature before the run.



WARNING

Do not use the Optima LE-80K in the vicinity of flammable liquids or vapors, and do not run such materials in the instrument. Do not lean on the instrument or place items on it while it is operating.



WARNING

Normal operation may involve the use of solutions and test samples that are pathogenic, toxic, or radioactive. Operator error or tube failure may generate aerosols. Do not run toxic, pathogenic, or other hazardous materials in this instrument unless you take all appropriate safety precautions. Ask your laboratory safety officer to advise you about the level of containment required for your application and the proper decontamination or sterilization procedures to follow in the event that fluids escape from containers.

The power must be turned on and the vacuum system turned off in order to open the chamber door.

STANDARD OPERATION

1. With the power on, open the chamber door, install the rotor, and close the chamber door. Press **(VACUUM)** if you want to evacuate the chamber now.
2. Enter the required run conditions (SPEED, TEMP, and TIME, HOLD, or ω^2t).
3. Select ACCEL and DECEL profiles if required. Otherwise, the instrument automatically selects maximum acceleration and deceleration rates.
4. Press **(ENTER/RECALL)** and **(START)**. (The vacuum system is automatically activated now, unless you pressed **(VACUUM)** earlier.)

Press **(STOP)** to terminate a run in the HOLD mode (or to stop any run for any reason). Runs in the timed and ω^2t modes terminate automatically and the instrument sounds a tone to indicate the end of the run. After the rotor has stopped, press **(VACUUM)** to vent the chamber.

Open the chamber door and remove the rotor. To keep the rotor chamber clean and dry, keep the door closed between runs.

To repeat a run, press **(ENTER/RECALL)** and **(START)**.

PROGRAMMED OPERATION

1. With the power on, open the chamber door, install the rotor, and close the chamber door. Press **(VACUUM)** if you want to evacuate the chamber now.
2. Press **(PROG)** and use the keypad to select a program number. (Or press **(PROG)** until the desired program appears.)
3. Press **(ENTER/RECALL)** and **(START)** to begin the run. (The vacuum system is automatically activated now, unless you pressed **(VACUUM)** earlier.)

Any of the run conditions can be changed while a programmed run is in progress. However, such changes will affect *only* the current run. To change a parameter during the run:

1. Press the appropriate parameter key (for example, **SPEED**).
2. Enter the new value.
3. Press **ENTER/RECALL**.

The run in progress will be modified accordingly.

Runs in the timed and $\omega^2 t$ modes terminate automatically when the set value is reached. After the rotor has stopped, press **VACUUM** to vent the chamber.

Open the chamber door, remove the rotor, and close the door. To keep the rotor chamber clean and dry, keep the door closed between runs.

DELAYED START PROGRAM FUNCTION

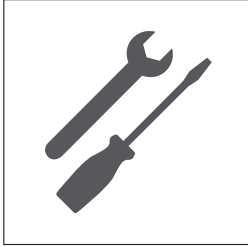
1. With the power on, open the chamber door, install the rotor, and close the chamber door.
2. Press **PROG**. Use the keypad to press **0** and then a second program number. Press **ENTER/RECALL**.
3. Press **ENTER/RECALL** and **START**.

The word “delay” appears in the **SPEED** display and the second program number appears in the **PROG** display. When the elapsed time in program 0 reaches zero, the second program begins automatically.

POINTS TO REMEMBER

- Keep the chamber door closed whenever possible. This helps to keep the chamber clean, as well as assuring optimum performance of the vacuum system.
- For fast temperature equilibration, cool or warm the rotor to the required temperature before the run.

- Refer to the applicable rotor manual for complete instructions on rotor preparation, use, and care.
- Refer to Section 4, TROUBLESHOOTING AND MAINTENANCE, if a diagnostic message flashes on the control panel during the run.



Troubleshooting and Maintenance

This section lists possible malfunctions, together with probable causes and corrective actions. Maintenance procedures are also described. Refer to the applicable rotor manual for instructions on the care of rotors and accessories. Troubleshooting and maintenance not covered in this manual should be handled by Beckman Coulter Field Service.

NOTE

It is your responsibility to decontaminate the instrument, as well as any rotors and/or accessories, before requesting service by Beckman Coulter Field Service.

IN CASE OF POWER FAILURE DURING THE RUN

If a power failure occurs during the run, the rotor begins to decelerate with the brake off. If the rotor is still spinning above 1000 rpm when power is restored, the instrument will resume operation and the rotor will return to set speed with maximum acceleration. A **PWR** diagnostic message will appear to alert you that a power outage occurred.

If the rotor is spinning below 1000 rpm or has stopped when the power is restored, the run automatically restarts. If the instrument is in the **TIME** mode, it will *automatically reset the TIME display to the original set time*. In the **HOLD** mode, the instrument will return to set speed and elapsed time will begin to accumulate again *from zero*. A **PWR** diagnostic message will appear to alert you that a power outage occurred and that the run has been restarted automatically.

RETRIEVING YOUR SAMPLE



WARNING

Any maintenance procedure requiring removal of a panel exposes the operator to the possibility of electrical shock and/or mechanical injury. Therefore, turn the power off and disconnect the instrument from the main power source, and refer such maintenance to service personnel.



WARNING

NEVER attempt to slow or stop the rotor by hand.



WARNING

The following procedure should be implemented only when absolutely necessary and only by qualified service personnel.

If a power failure lasts for several hours, it may be necessary to retrieve the sample from the rotor. (A rotor decelerating without the brake may take hours to come to a complete stop.) To gain access to the rotor, it will be necessary to remove the control head cover and the front panel to disengage the door lock.

1. Locate the two metal latches (see Figure 4-1) at the lower outside corners on the back of the control head. Use your fingers to depress the latches to disengage the cover from the control head. With both hands, lift it slightly and pull it toward you until it is free. Set the cover aside in a safe place.
2. To remove the front panel, use a long, thin tool (about 1.5 mm in diameter) to depress the latch (see Figure 4-2). While the latch is depressed, use your free hand to lift the top panel until it stops, remove the tool, then continue lifting the top panel to free the front panel. Let the front panel tilt toward you.
3. Lift the front panel to free the bottom tabs that secure it in place.

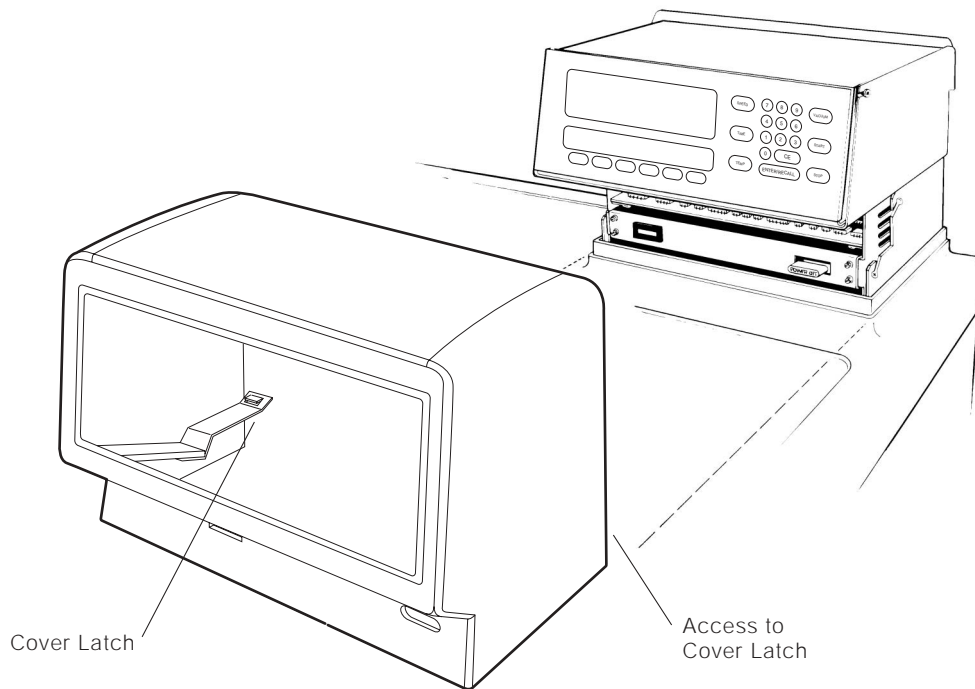


Figure 4-1. Removing the Control Head Cover



WARNING

After removing the panel, listen carefully for any sounds coming from the drive. Then touch the fan housing (Figure 4-3) to feel if it is vibrating and listen again. Do not proceed if any sound or vibration is emitted from the housing.

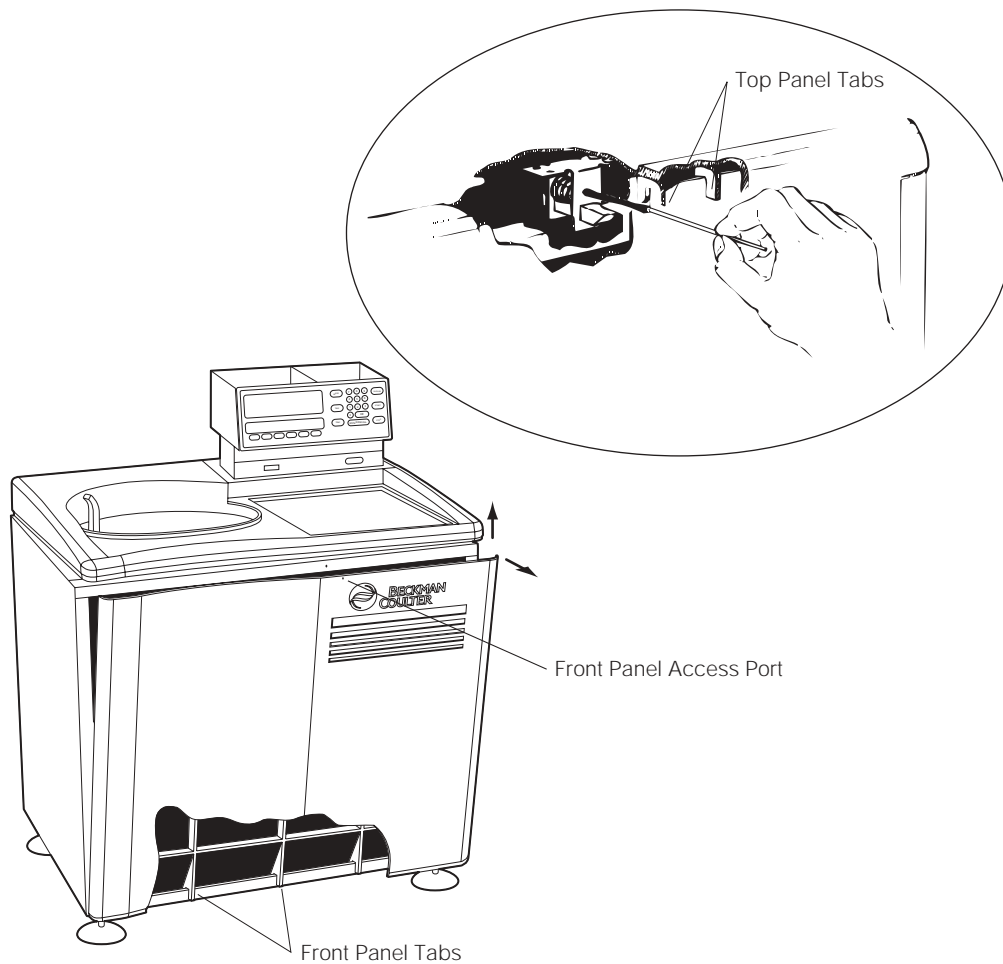


Figure 4-2. Depressing the Latch to Loosen the Front Panel

4. Vent the vacuum chamber by slowly turning the small setscrew on the vacuum solenoid valve to the right (clockwise) until you hear the air released into the chamber. If you hear a whining noise, close the valve and wait, because the rotor is still spinning.
5. About 10 seconds after the hissing noise stops, turn the screw to the left (counterclockwise) until it stops.
6. Push down on the interlock pin (Figure 4-3) with your finger while opening the chamber door with your free hand. (If the rotor is still spinning, close the door and wait.) Be very careful not to touch any wires or circuitry.

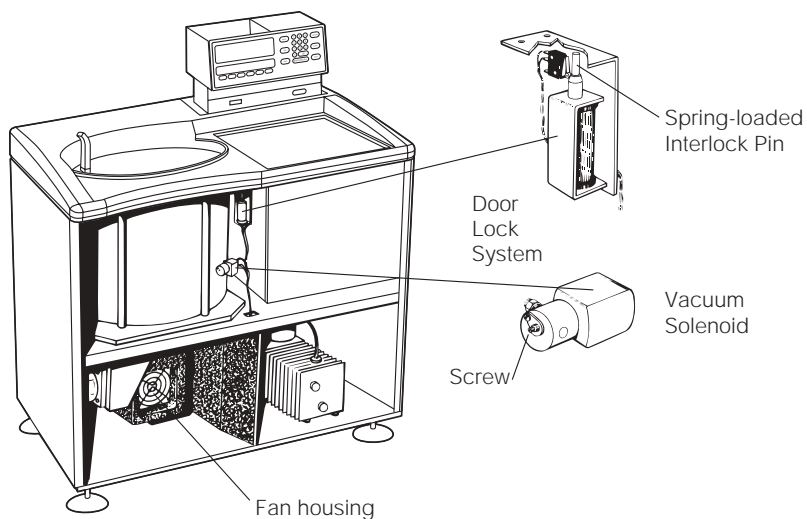


Figure 4-3. Interior View of Instrument

7. After retrieving the sample, close the chamber door, then replace the front panel on the instrument. Insert the tabs at the bottom of the front panel onto the lip at the base of the instrument, being sure to align the front panel with the side panels (see Figure 4-4).
8. Lift the front edge of the top panel a few inches and insert the upper edge of the front panel under it. Push back gently to engage the tabs, then down to activate the latch.
9. Replace the control head by sliding it along the small ridges provided, making sure to clear the emergency POWER OFF switch in front. When the control head cover is correctly positioned, push it until the latches snap shut and the cover is aligned with the rest of the instrument panels.



WARNING

Do not attempt to run the instrument before returning the front panel to its correct position.

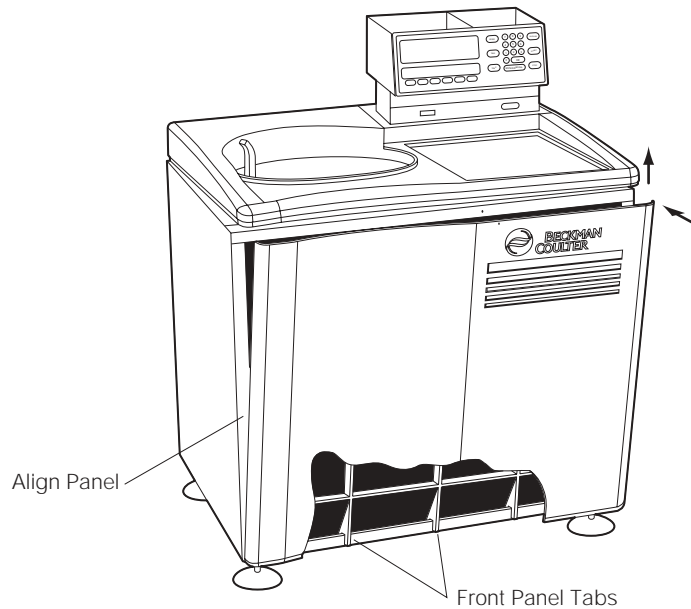


Figure 4-4. Reinstalling the Front Panel

DIAGNOSTIC MESSAGES

Diagnostic messages appear as red LEDs at the left side of the upper display (see Figure 4-5) to alert you to conditions that may need your attention. A tone will sound and the appropriate message will blink until you press the **(CE)** key. The diagnostic messages will reappear if you attempt to restart the instrument before the problem is corrected.

Some of the messages are intended to provide cautionary information that will not shut down a run in progress. Others indicate a user error. For example, if you left the chamber door open when you pressed **(START)**, the **DOOR** message would appear to let you know it must be closed.

If the associated display is flashing when a diagnostic message appears, a shut-down malfunction has occurred. The run will come to a stop.

See Table 4-1 to determine the nature of the error or problem, possible causes, and recommended corrective actions. If no user action is indicated, or the error persists, call Beckman Coulter Field Service for assistance.

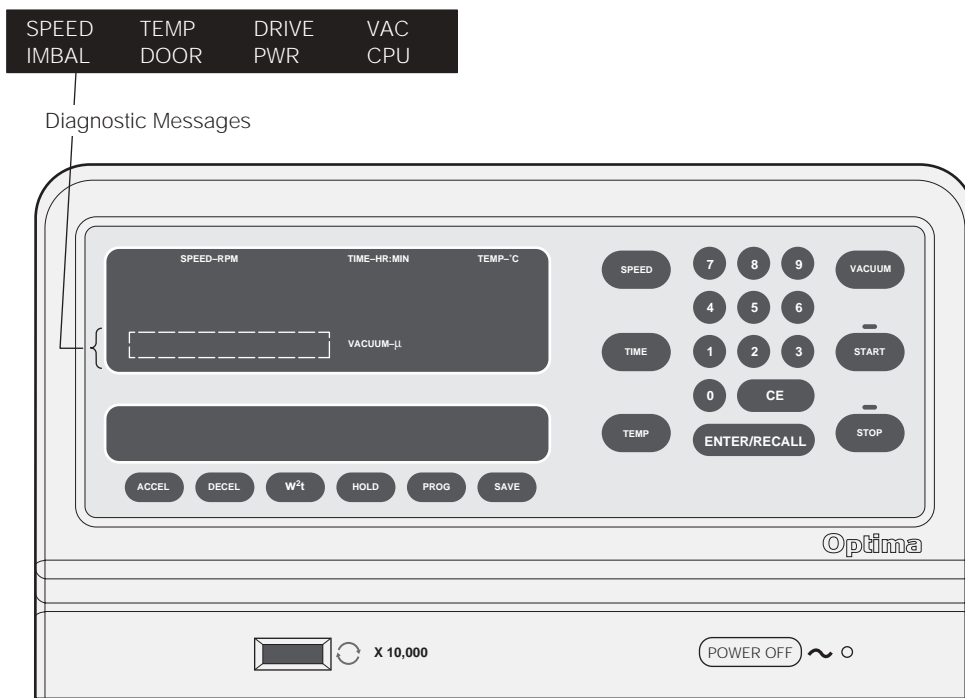


Figure 4-5. Location of Diagnostic Messages on the Control Panel

CLEANING

Keep instrument surfaces clean by wiping them with a cloth dampened with a mild detergent such as Beckman Solution 555™ (diluted 10 to 1 with water). If salts or other corrosive materials are used, or if spillage occurs, wash all affected areas immediately. Do not allow corrosive materials to dry on the instrument. (Be careful not to spill liquid on the instrument where electrical or mechanical components could get damaged.)

ROTOR CHAMBER

The rotor chamber is coated with epoxy resin paint, and the chamber door O-ring is Buna N rubber. The chamber can be wiped clean with a cloth dampened with a mild detergent such as Solution 555. The O-ring should be cleaned with a tissue or soft cloth every 3 or 4 months. Replace the O-ring whenever it becomes worn or damaged. Lightly coat the O-ring with silicone vacuum grease (335148) before reinstalling it to ensure an optimum vacuum seal. (Instrument O-rings have not been designed as bioseals for aerosol containment.)

Table 4-1. Diagnostic Troubleshooting Chart

Diagnostic Message	Possible Cause	User Action
SPEED	Speed has been set above the maximum allowable for the rotor; or wrong, damaged, or missing overspeed disk on the installed rotor	Check set speed; check the rotor for clean, undamaged, and correct overspeed disk (see the <i>Rotors and Tubes</i> manual [LR-IM] for replacement instructions).
TEMP	Temperature control or vacuum system malfunctioning	Check the air inlet (at bottom of the front panel) for obstructions. Call Beckman Coulter Field Service if problem persists.
DRIVE	Abnormal change in drive speed or overheated drive	Be sure a rotor is properly installed on the spindle; if power has failed, wait for 5 minutes for drive to cool; check for air inlet obstruction.
VAC	Vacuum not being drawn properly	<ul style="list-style-type: none"> • Check door O-ring for damage and dirt. • Check rotor lid O-rings for possible leakage. • Check the vacuum oil. If milky in color, run the vacuum system for several hours or overnight until the oil is clear.
IMBAL	Rotor imbalance (at low speeds)	Check for proper rotor loading.
DOOR	Door is open when the START key is pressed	Be sure door is closed.
PWR	Loss of power during run	Check TIME display; the run may need to be restarted or aborted.
CPU	Microprocessor malfunction or loss of program memory	No user action. Call Beckman Coulter Field Service.

 **NOTE**

Keep the chamber door closed between runs to keep the chamber clean and dry. If necessary, wipe off the chamber walls with a dry cloth before operation.

Do not place containers holding liquid near the, chamber door. Spilled liquid can damage electrical or mechanical components.

DECONTAMINATION

If the instrument and/or accessories are contaminated with radioactive or pathogenic solutions, follow appropriate decontamination procedures as determined by your laboratory safety officer. Refer to *Chemical Resistances* (publication IN-175), or contact Beckman Coulter Field Service to ensure that the decontamination method does not damage any part of the instrument (or accessories).

STERILIZATION AND DISINFECTION

The top working surface is finished with urethane paint; the sides are finished with general purpose paint. Ethanol (70%)¹ may be used on both these surfaces. See *Chemical Resistances* for more information regarding chemical resistance of instrument and accessory materials.

While Beckman Coulter has tested these methods and found that they do not damage the instrument, no guarantee of sterility or disinfection is expressed or implied. When sterilization or disinfection is a concern, consult your laboratory safety officer regarding proper methods to use.

STORAGE AND TRANSPORTATION

Contact Beckman Coulter Field Service for specific instructions and/or assistance in preparing the instrument for transport or long-term storage. Temperature and humidity requirements for storage should meet the environmental requirements described under SPECIFICATIONS at the front of this manual.

¹ Flammability hazard. Do not use in or near operating ultracentrifuges.

SUPPLY LIST

NOTE

To obtain copies of referenced publications, contact Beckman Coulter, Inc., Technical Publications Department, 1050 Page Mill Road, Palo Alto, CA 94304, U.S.A. (Telephone 650-859-1753; Fax 650-859-1375).

Call Beckman Coulter Sales (1-800-742-2345 in the United States; worldwide offices are listed at the back of this manual) or see *Ultracentrifuge Rotors, Tubes & Accessories* (BR-8101, available at www.beckmancoulter.com) for detailed information on ordering parts and supplies. For your convenience, a partial list is given below.

Silicone vacuum grease (2 oz)	335148
Spinkote lubricant (1 oz)	306812
Beckman Solution 555 (1 qt)	339555
Chamber O-ring	801778
Logbook for Ultracentrifuges	330049
Master Rotor Logbook	339587
Direct-drive vacuum pump oil (1 L)	341661
Diffusion pump oil (250 cc)	330246

SPECIAL WARRANTY FOR THE OPTIMA™ L, LE, XL, AND L-XP PREPARATIVE ULTRACENTRIFUGES AND THE OPTIMA™ XL-A AND XL-I ANALYTICAL ULTRACENTRIFUGES

Subject to the exceptions and upon the conditions specified below, Beckman Coulter, Inc., agrees to correct, either by repair, or, at its election, by replacement, any defects of material or workmanship which develop within one (1) year after delivery of the Optima Ultracentrifuge (the product), to the original Buyer by Beckman Coulter, or by an authorized representative, provided that investigation and factory inspection by Beckman Coulter discloses that such defect developed under normal and proper use.

Some components and accessories by their nature are not intended to and will not function for as long as one (1) year. If any such component or accessory fails to give reasonable service for a reasonable period of time, Beckman Coulter will repair or, at its election, replace such component or accessory. What constitutes either reasonable service and a reasonable period of time shall be determined solely by Beckman Coulter.

REPLACEMENT

Any product claimed to be defective must, if requested by Beckman Coulter be returned to the factory, transportation charges prepaid, and will be returned to Buyer with the transportation charges collect unless the product is found to be defective, in which case Beckman Coulter will pay all transportation charges.

Beckman Coulter makes no warranty concerning products or accessories not manufactured by it. In the event of failure of any such product or accessory, Beckman Coulter will give reasonable assistance to the Buyer in obtaining from the respective manufacturer whatever adjustment is reasonable in light of the manufacturer's own warranty.

Damage to the instrument while operating a rotor not of Beckman Coulter manufacture is not covered by warranty or service contract terms. Further, Beckman Coulter shall be released from all obligations under all warranties either expressed or implied, if the product covered hereby is repaired or modified by persons other than its own authorized service personnel, unless such repair is made by others who meet qualifications similar to those required of Beckman Coulter's service personnel, or unless such repair in the sole opinion of Beckman Coulter is minor, or unless such modification is merely the installation of a new Beckman Coulter plug-in component for such product.

SPECIAL DRIVE WARRANTY

During the instrument warranty period (one year), there will be no charge for drive replacement if the drive unit is installed, serviced, and operated in accordance with the conditions listed

below. During the drive's second through tenth year of use there is a prorated drive replacement price based on years of use if the drive unit is installed, serviced, and operated in accordance with the conditions listed below.

Drive replacement price for units not under service contract*
= current drive exchange price

$$\times \left(\frac{\text{years of use}}{10} \right) + \text{labor and travel.}$$

CONDITIONS

1. The drive has been operated only within its rated speed and temperature ranges.
2. The drive unit has not been subjected to unequal loading, improper rotor installation, corrosion from material spilled onto the hub or accumulated in the chamber of the instrument.
3. The drive unit has not been disassembled, modified, or repaired, except by Beckman Coulter personnel.
4. The drive unit was installed by a Beckman Coulter Field Service representative.
5. The instrument in which the drive unit has been used and operated, and its associated rotors, were manufactured by Beckman Coulter and serviced only by Beckman Coulter Field Service representatives.

If the above conditions are not met, the full appropriate exchange price for the drive will be charged.

DISCLAIMER

IT IS EXPRESSLY AGREED THAT THE ABOVE WARRANTY SHALL BE IN LIEU OF ALL WARRANTIES OF FITNESS AND OF THE WARRANTY OF MERCHANTABILITY AND THAT BECKMAN COULTER, INC. SHALL HAVE NO LIABILITY FOR SPECIAL OR CONSEQUENTIAL DAMAGES OF ANY KIND WHATSOEVER ARISING OUT OF THE MANUFACTURE, USE, SALE, HANDLING, REPAIR, MAINTENANCE, OR REPLACEMENT OF THE PRODUCT.

* For details of drive coverage with a service contract, contact your local Beckman Coulter service representative.

Beckman Coulter Worldwide Life Science Research Division Offices

AUSTRALIA

Beckman Coulter Australia Pty Ltd
Unit D, 24 College St.
Gladesville, NSW 2111
Australia
Telephone: (61) 2 9844-6000
or toll free: 1 800 060 880
Fax: (61) 2 9844-6096
email: lifescienceaustralia@beckman.com

CANADA

Beckman Coulter (Canada) Inc.
6755 Mississauga Road, Suite 600
Mississauga, Ontario
Canada L5N 7Y2
Telephone: (905) 819-1234
Fax: (905) 819-1485

CHINA

Beckman Coulter Inc.
Beijing Representative Office
Unit 2005A, 2006-2009, East Ocean Center
Jian Guomenwai Avenue
Beijing 100004
China
Telephone: (86) 10 6515 6028
Fax: (86) 10 6515 6025, 6515 6026

EASTERN EUROPE/ MIDDLE EAST/NORTH AFRICA

Beckman Coulter International S.A.
22, Rue Juste-Olivier
Case Postale 301-303
CH-1260 Nyon, Switzerland
Telephone: (41) 22 994 07 07
Fax: (41) 22 994 07 00

FRANCE

Beckman Coulter France S.A.
Paris Nord II, 33/66 rue des Vanesses
B.P. 50359
Villepinte, France
95942 ROISSY CDG Cedex
Telephone: 01 49 90 90 00
Fax: 01 49 90 90 10
e-mail: bioresearch.france@beckman.com

GERMANY

Beckman Coulter GmbH
Siemensstrasse 1
D-85716 Unterschleissheim-Lohhof
Germany
Telephone: (89) 35870-0
Fax: (89) 35870-490
e-mail: bioresearch.de@beckman.com

HONG KONG

Beckman Coulter Hong Kong Ltd.
12th Floor, Oxford House
979 King's Road
Taikoo Place, Hong Kong
Telephone: (852) 2814 7431, 2814 0481
Fax: (852) 2814 1599, 2873 4511

ITALY

Beckman Coulter S.p.a.
Centro Direzionale Lombardo
Palazzo F/1, Via Roma 108
20060 Cassina de' Pecchi
Milano, Italy
Telephone: 02-953921
Fax: 02-95392264

JAPAN

Beckman Coulter K.K.
Toranomon 37 Mori Bldg.
3-5-1, Toranomon
Minato-ku, Tokyo 105-0001
Japan
Telephone: 03-5404-8359
Fax: 03-5404-8436

MEXICO

Beckman Coulter de Mexico S.A. DE C.V.
Avenida Popocatepetl #396
Colonia Gral. Pedro Maria Anaya
Codigo Postal 03340
Maxico, D.F. / Mexico City
Telephone: 525 605-77-70
Fax: 525 575-18-25

NETHERLANDS

Beckman Coulter Nederland B.V.
Nijverheidsweg 21
3641 RP-Mijdrecht
Postbus 47
3640 AA Mijdrecht
The Netherlands
Telephone: 0297-230630
Fax: 0297-288082

SINGAPORE

Beckman Coulter Singapore Pte. Ltd.
116 Changi Road
Unit #03-01/02
Singapore 419718
Telephone: (65) 6339 3633
Fax: (65) 6336 6303

SOUTH AFRICA/SUB-SAHARAN AFRICA

Beckman Coulter
Stand 1A Primegro Park
Tonetti Street
1685 Halfway House
Johannesburg
Republic of South Africa
Telephone: (27) 11-805-2014/5
Fax: (27) 11-805-4120
e-mail: beckman@intekom.co.za

SPAIN

Beckman Coulter España S.A.
C/ Caleruega, 81
28033 Madrid, Spain
Telephone: (34) 91 3836080
Fax: (34) 91 3836096
email: bioresearch.espana@beckman.com

SWEDEN

Beckman Coulter AB
Archimedesvaegen 7
Box 111 56
SE-168 11 Bromma
Sweden
Telephone: (0)8 564 85 900
Telefax: (0)8 564 85 901

SWITZERLAND

Beckman Coulter International S.A.
22, Rue Juste-Olivier
Case Postale 301-303
CH-1260 Nyon
Switzerland
Telephone: 0800 850 810
Fax: 0848 850 810

TAIWAN

Beckman Coulter Taiwan Inc.
Taiwan Branch
8th Floor
216 Tun Hwa South Road, Section 2
Taipei 106, Taiwan
Republic of China
Telephone: (886) 2 2378 3456
Fax: (886) 2 2377 0408

TURKEY

Beckman Coulter Ltd.
E-5 Yanyol Faith Cad.
81410 Soganlik Kartal
Istanbul
Turkey
Telephone: 90 216 309 1900
Fax: 90 216 309 0090

UNITED KINGDOM

Beckman Coulter United Kingdom Ltd
Oakley Court
Kingsmead Business Park
London Road
High Wycombe
Buckinghamshire HP11 1JU
England, U.K.
Telephone: 01494 441181
Fax: 01494 447558
e-mail: beckman_uk@beckman.com

Authorized dealers in other countries.



Beckman Coulter, Inc. • 4300 N. Harbor Boulevard, Box 3100 • Fullerton, California 92834-3100
Sales: 1-800-742-2345 • Service: 1-800-551-1150 • Internet: www.beckmancoulter.com • Telex: 678413 • Fax: 1-800-643-4366



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