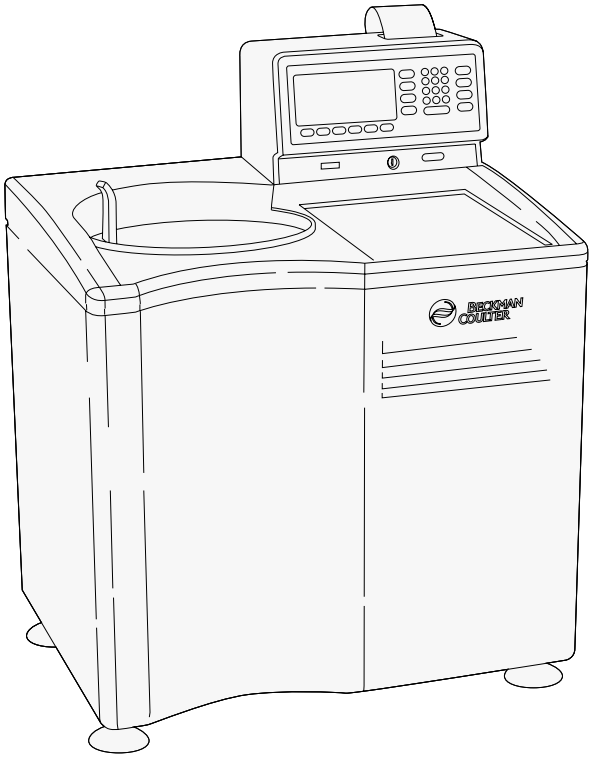
LXL-IM-10

BECKMAN COULTER™

Optima™ XL Series

Preparative Ultracentrifuge



Instruction Manual

PUBLISHED BY THE SPINCO BUSINESS CENTER OF BECKMAN COULTER, INC., PALO ALTO, CALIFORNIA 94304

Symbol Symbol Symbole Símbolo Simbolo 記号	Title / Titel / Titre / Titulo / 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*.

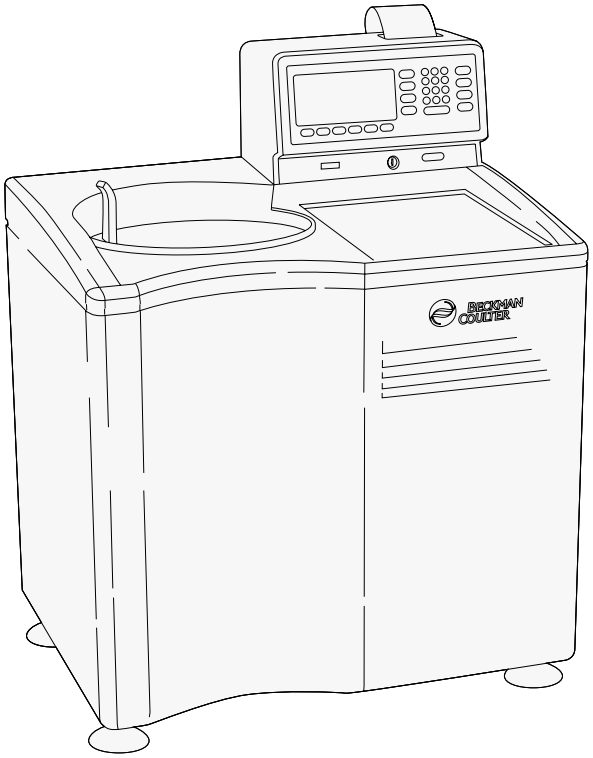
- Handle body fluids with care because they can transmit disease. No known test offers complete assurance that they are free of micro-organisms. Some of the most virulent—Hepatitis (B and C) and HIV (I–V) viruses, atypical mycobacterium, and certain systemic fungi—further emphasize the need for aerosol 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 a Beckman Coulter Field Service representative.

LXL-IM-10
May 2001

Optima™ XL Series

Preparative Ultracentrifuge



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Introduction

INSTRUMENT CERTIFICATION

To assure full system quality, Beckman Coulter Optima™ Series XL preparative ultracentrifuges have been manufactured in an NSAI-registered ISO 9001 facility. They have been designed and tested to meet the laboratory equipment standards and regulations (only when used with Beckman Coulter rotors) of:

- UL
- CSA
- CE Mark

INTRODUCTION

The Optima XL ultracentrifuge is used to generate centrifugal forces for the separation of particles. It is available in three models: the XL-100K, XL-90K, and XL-80K, with maximum speeds of 100 000, 90 000, and 80 000 rpm respectively. Classified “S,” it can be used with all currently manufactured Beckman Coulter preparative rotors; it is also designed for zonal and continuous flow operation.

The Optima XL is microprocessor-controlled, providing interactive, menu-driven operation. Software functions assist with run preparation and optimizing the efficiency of separations. The Optima XL has an extensive database of rotor specifications and catalog of available Beckman Coulter rotors, the ability to perform common centrifugation-related calculations, and the ESP™ Efficient Sedimentation Program, which simulates the formation of the gradient and separation of sample components in a wide selection of rotors.

The Optima XL also provides a Program Library, which can hold up to nine standard programs and a multi-step sequential program, rotor usage logging, and a built-in printer for printing rotor and run data.

SCOPE OF THIS MANUAL

This manual is designed to familiarize you with the specifications, operation, and routine operator care of the Optima XL.

- The following introductory pages contain the instrument specifications and installation requirements.
- Sections 1 and 2 describe the major instrument components and how to use the Optima XL software to enter run conditions.
- Sections 3 through 7 provide information on the additional features described above.
- Section 8 provides a summary of run procedures.
- Section 9 discusses the care of your Optima XL and what to do if it malfunctions.

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

NOTE

If the ultracentrifuge is used in a manner other than specified in this manual, the safety and performance of this equipment 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.

To obtain additional copies of this manual, related rotor manuals, and other 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)

CONVENTIONS

Certain symbols are used in the manual to call out safety related and other important information. These are reproduced and described below.

NOTE

Used to call attention to important information that should be followed during installation, use, and/or servicing of this 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 when 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 qualified service personnel.

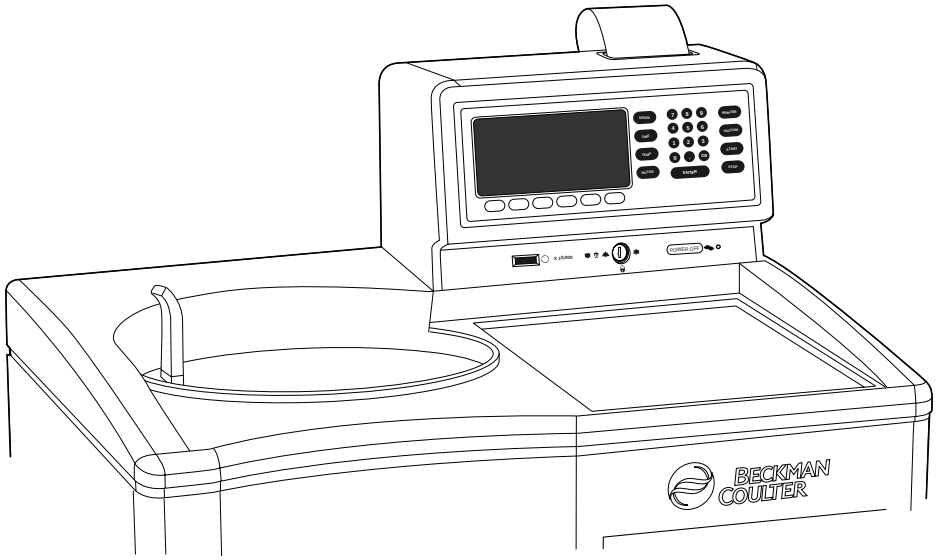
RADIO INTERFERENCE

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 reglement sur le brouillage radioelectrique édicté par le Ministère des Communications du Canada.



SPECIFICATIONS

CONTROL FEATURES

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

Speed

Set speed	1000 to maximum speed[1] in increments of 100 rpm
Speed control	actual rotor speed will be ±20 rpm of the set speed (above 1000 rpm)

[1] Maximum speed will be 100 000, 90 000, or 80 000 rpm, depending on the model purchased.

Speed display	indicates rotor speed in increments of 10 rpm at speeds below 1000 rpm and 100 rpm at speeds above 1000 rpm
Time	
Set time	up to 999 hours and 59 minutes; HOLD for runs of unspecified length
Time display	indicates time remaining in timed runs, time elapsed in HOLD runs, and estimated time remaining in $\omega^2 t$ runs
Rotor Temperature	
Set temperature	0 to 40°C in increments of 1°C
Temperature control	±0.5°C of set temperature
Temperature display	indicates rotor temperature in increments of 0.1°C
Temperature stability	within 0.3°C after equilibration
$\omega^2 t$ **Integrator**	
Set $\omega^2 t$	up to 9.99×10^{14} radians squared per second
$\omega^2 t$ display	shows the accumulated $\omega^2 t$ to three significant digits (in exponential notation)
Acceleration	nine slow acceleration profiles, or maximum acceleration from 0 rpm to set speed
Deceleration	nine slow deceleration profiles, no brake, or maximum deceleration from set speed to 0 rpm
Operation	standard or programmed; instrument memory can store up to nine individual programs and one sequential program of up to five steps
Key Switch	used to select normal, zonal, or locked operation
Diagnostic Messages	see Troubleshooting Chart in Section 9

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 13-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	S (uses all Beckman Coulter preparative rotors except Types 35 and 42.1 with serial numbers 1299 or lower)
RS 232C Accessory Port	external connection to provide standard RS 232C interface for computer remote control. Connector is is a 25-pin female DIN connector, which mates with a 25-pin male DIN connector.

INSTALLATION REQUIREMENTS

CAUTION

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

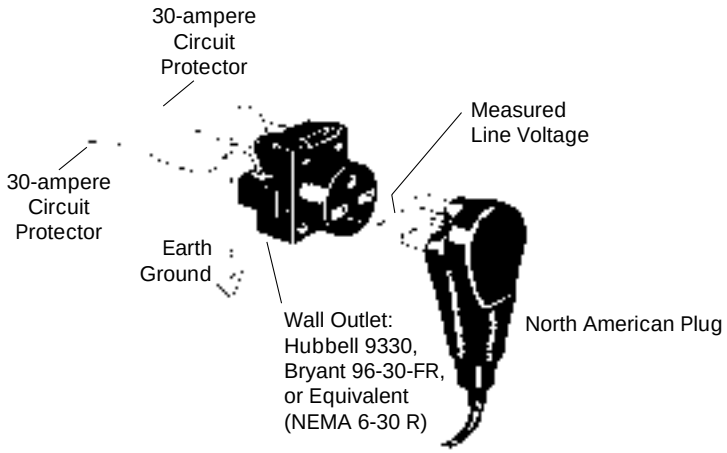
PREINSTALLATION REQUIREMENTS

Preinstallation requirements have been sent prior to shipment of the instrument. (Copies are also attached to the outside of the shipping container.) The following information is provided in case the Optima XL 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 the 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 earth ground. 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.



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.

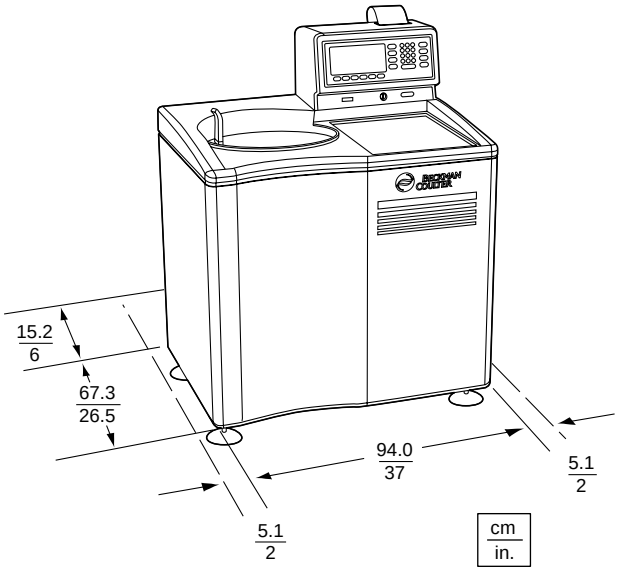
Required Wire Connections

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

Space

Locate the Optima XL in a clean, safe, uncluttered environment. Be sure to provide a 5.1-cm (2-in.) clearance on each side of the Optima XL as the feet extend about 5.1 cm (2 in.) beyond the instrument. (The pads under each foot are 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 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.



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 instrument	57 dBa
Installation category	II
Pollution degree	2

1
Description

This section describes major instrument components.

POWER

A circuit breaker, labeled I (on) and O (off), is located on the right side panel of the Optima XL and controls the electrical power to the instrument. Power may be left on (see Standby Mode below) except in the case of an emergency or when maintenance is required.

A red POWER OFF button is located 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.

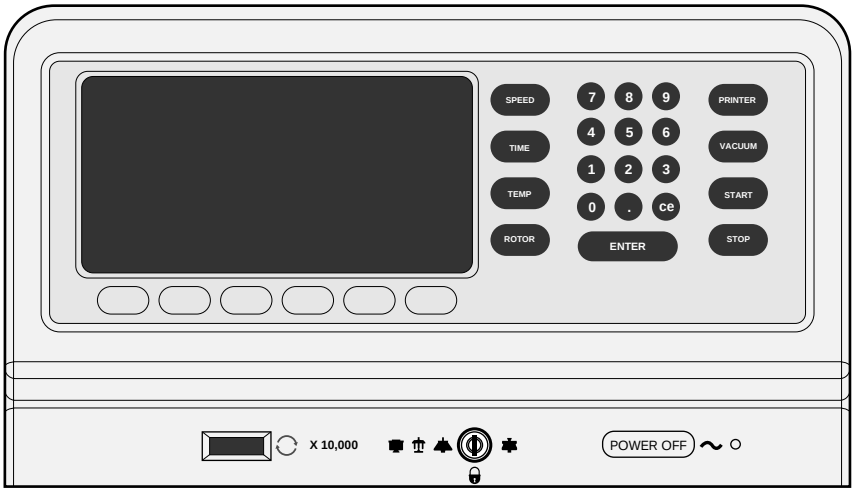


Figure 1-1. Optima XL Control Head

STANDBY MODE

When the instrument is at rest, it goes into a “Standby Mode”—a condition that requires only minimal power to keep the instrument in a ready state. In standby mode a screen-saver allows the screen to go blank until the instrument is returned to its full operational condition, or “Operating Mode,” when any key on the control panel is pressed.

KEY SWITCH POSITIONS

A key interlock switch is used to select normal, locked, or zonal operation (see Figure 1-2). Use the normal position for routine closed-door centrifugation, the locked position to ensure that the settings do not get changed during the run, and the zonal position for runs in which a zonal rotor is loaded and unloaded while spinning. (The key cannot be removed while in the zonal position.)

REVOLUTIONS COUNTER

A seven-digit revolutions counter, located to the left of the key switch, displays the accumulated number of rotor revolutions in tens of thousands of revolutions.

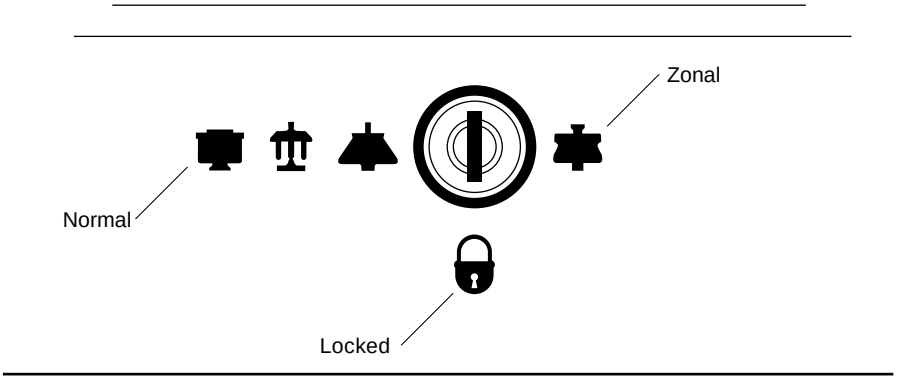


Figure 1-2. Key Switch Positions

CONTROL PANEL

Figure 1-3 shows the Optima XL control panel, which includes a video display and keys for entering run information or accessing additional instrument features. (See Section 2 for a detailed discussion on how to enter run information.)

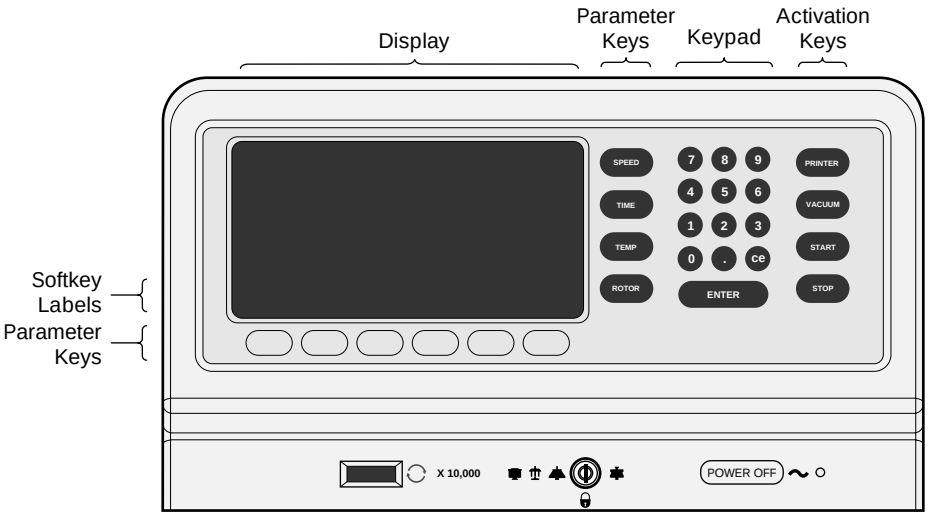


Figure 1-3. The Control Panel

HARDKEYS

- Parameter hardkeys are used to enter run conditions. They are SPEED, TIME, TEMP, and ROTOR and are located to the left of the keypad. (On certain screens, ROTOR is also available as a softkey.)
- Activation hardkeys are provided to control specific ultracentrifuge functions. They are PRINTER, VACUUM, START, and STOP and are 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, a . (decimal) key, and an ENTER key.

SOFTKEYS

Six unlabeled softkeys are located along the bottom of the control panel, beneath the video display. Labels appear in reverse video, directly above each softkey, and change as required to indicate the current function of the key.

DISPLAY

The Optima XL is a microprocessor-controlled ultracentrifuge with interactive, menu-driven operation. A display shows the current values and run settings as well as a variety of run-related functions, which are accessed by pressing the appropriate keys.

A small setscrew on the back of the control head controls the brightness of the video display (see “Adjusting the Brightness of the Video Display” in Section 9).

PRINTER

The printer, located within the control head, provides printouts of rotor and run data (Figure 1-4). A menu of printer options is accessed via the PRINTER hardkey (see Section 5).

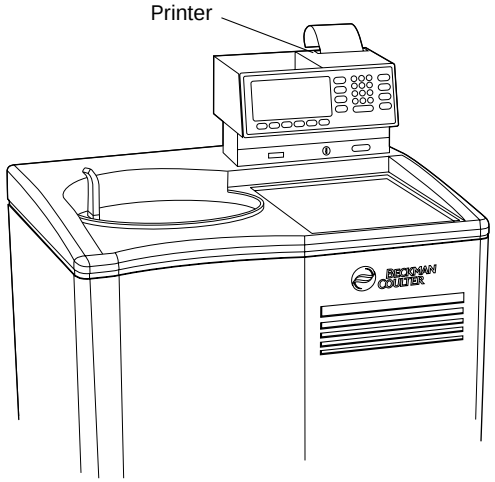


Figure 1-4. Location of Printer Within Control Head

ROTOR CHAMBER

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 if the power is on and the vacuum is off, with the chamber at atmospheric pressure. See Section 9 for instructions on accessing the chamber to retrieve your sample in case of a power outage.

The rotor chamber is 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 (see Figure 1-5).

Figure 1-5. The Rotor Chamber

VACUUM SYSTEM

The Optima XL uses a diffusion pump in series with a mechanical vacuum pump to reduce chamber pressure to below 5 microns (0.7 Pa). The system is automatically activated when ENTER and START are pressed, or may be turned on directly by pressing VACUUM, providing the chamber door is closed. The vacuum system is also automatically activated when PRECOOLING or PREHEATING of the rotor is selected. (When the rotor is at rest, the instrument maintains a partial vacuum.) When the vacuum system is on, the chamber pressure is displayed in microns in the lower left corner of the CURRENT VALUES window.

At the end of a run, the chamber vacuum must be vented (by pressing VACUUM) before the door can be opened. (The vacuum *cannot* be turned off when the rotor is spinning faster than 3000 rpm. If pressed, an error message will appear.) After the door is opened, the chamber is brought to approximate room temperature to minimize condensation collecting in the chamber. To

help keep the chamber dry and clean, it is important to keep the door closed whenever possible.

In zonal operation, the door may be kept open while the rotor is spinning up to 3000 rpm. The vacuum system is activated when the door is closed (after loading the rotor) and can be vented before the rotor is unloaded, while the rotor is still spinning at up to 3000 rpm. See “Key in the Zonal Position” in Section 8 for more information.

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. See the Troubleshooting Chart in Section 9 for information on correcting this situation.

TEMPERATURE SENSING

Rotor temperature is monitored by a radiometer mounted in the bottom of the rotor chamber (see Figure 1-5) when the chamber pressure is below 100 microns. Above 100 microns, *chamber* temperature is measured by a thermistor mounted in the chamber. (If the radiometer fails, a diagnostic message will appear and the system will revert to control by the thermistor; however, the run will continue.)

TEMPERATURE CONTROL SYSTEM

The Optima XL uses a solid state thermoelectric refrigeration and heating system, which eliminates the need for a more complex, conventional refrigeration system and heater. Neither Freon[1] nor water is needed; the only coolant required is forced air from the fans.

After the power is turned on, the temperature control system activates when the door is closed and the vacuum system is turned on. The displayed rotor temperature is controlled to ±0.5°C of the set value.

Run temperature can be set at 0 to 40°C. If no temperature setting has been entered, the instrument automatically selects 25°C (the default value) as its operating temperature.

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

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 a photoelectric device in the rotor chamber next to the drive spindle (see Figure 1-5) 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 the electronic circuitry and software.

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 $\omega^2 t$ mode, the time setting is recalculated to give an equivalent $\omega^2 t$ value.)

ROTOR ENERGY SYSTEM

As the rotor accelerates between 15 000 and 20 000 rpm, rotor inertia is measured and the rotor energy is calculated for the speed set by the user. If the calculated rotor energy is determined to be excessive, the instrument recalculates a permitted set speed and uses this value to avoid possible rotor damage. A diagnostic message is displayed to indicate the change.

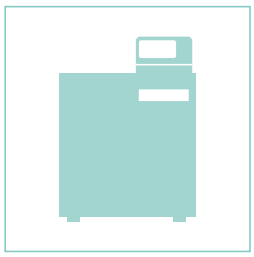
DRIVE

The Optima XL 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 Optima XL drive delivers ultra-smooth, quiet performance, with high tolerance of rotor imbalance.

[2] U.S. Patent No. 4,846,773.

2

Run Preparation



This section contains an explanation of the general format of the software and how to enter run information.

SCREEN FORMAT

The software is presented as a series of windows, either half or full-screen width, containing certain kinds of information at the same place in the display. For example, a title bar always appears at the top left corner of each window and softkey labels always appear on the two lines just above the soft-keys. Some information is highlighted in reverse video to emphasize its importance, to indicate that you are in the process of editing that field, or to alert you to a condition that needs your attention.

PROMPT LINES

The two lines directly below the window(s) display information to assist you in completing the operation under way or to access other screens.

ERROR AND DIAGNOSTIC MESSAGES

Error and diagnostic messages appear in reverse video under the window(s)—the area where prompt lines usually appear. Error messages indicate user mistakes that can be corrected (such as entering a value with too many digits). Diagnostic messages alert you to conditions that need your attention. These messages and the appropriate actions to take are discussed in the Trouble-shooting Chart in Section 9.

MAIN SCREEN

The Main Screen will usually be displayed—unless you have selected a function that temporarily requires using part or all of the screen (such as viewing the ROTOR CATALOG and SPECIFICATIONS windows). The Main Screen shows the actual conditions of the instrument (CURRENT VALUES) on the left and user-entered values (SETTINGS) on the right (Figure 2-1).

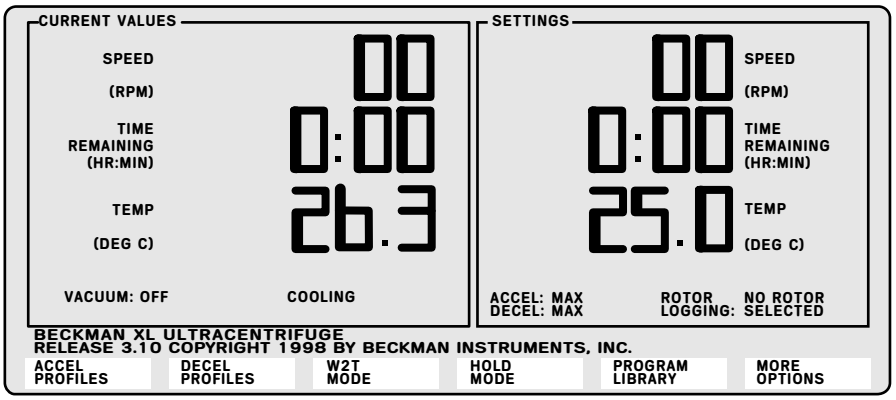


Figure 2-1. The Main Screen

CURRENT VALUES WINDOW

This window (Figure 2-2) displays actual run conditions: speed, time, and temperature. The value shown in the TIME display depends on the run-termination mode.

- In TIME mode, the display shows the time *remaining* in the run.
- In $\omega^2 t$ mode, the display shows *a calculation* of the time remaining,
- In HOLD mode, the display shows the *elapsed* time.

Messages in the lower left corner of the CURRENT VALUES window provide additional information on the current instrument status. For example, the chamber pressure, in microns, is displayed when the vacuum system is on, and the current value for $\omega^2 t$ is shown when the instrument is in the $\omega^2 t$ mode. In the lower right corner of the window, a message indicates if the instrument is in a locked or zonal operation.

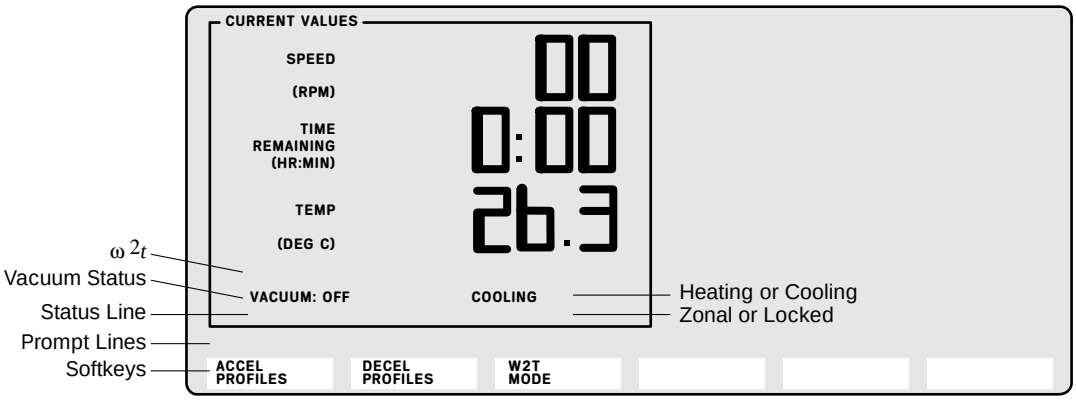


Figure 2-2. CURRENT VALUES Window

RUN STATUS MESSAGES

The following messages indicate the status of the instrument:

COOLING: The instrument is cooling the chamber and/or rotor to the set temperature.

HEATING: The instrument is heating the chamber and/or rotor to the set temperature.

ACCELERATING: The rotor is accelerating to set speed.

DECELERATING: The rotor is decelerating from one set speed to another.

RUNNING: The rotor is spinning at set speed.

STOPPING: The rotor is coming to a stop at the end of a run or because the (STOP) key was pressed.

ZONAL SETUP: The key is in the zonal position, the rotor is spinning up to 3000 rpm, and the door is open.

WAIT FOR VAC: The instrument is holding the speed at 3000 rpm until the chamber pressure drops below 750 microns.

STOP VALUES WINDOW

A set of conditions called STOP VALUES is displayed in place of the CURRENT VALUES when (STOP) is pressed to end a run (Figure 2-3). STOP VALUES can also be displayed by pressing (ENTER) and (STOP). These are the run conditions, including the accumulated $\omega^2 t$ value, that existed when the rotor began decelerating. The CURRENT VALUES window automatically returns after 5 seconds.

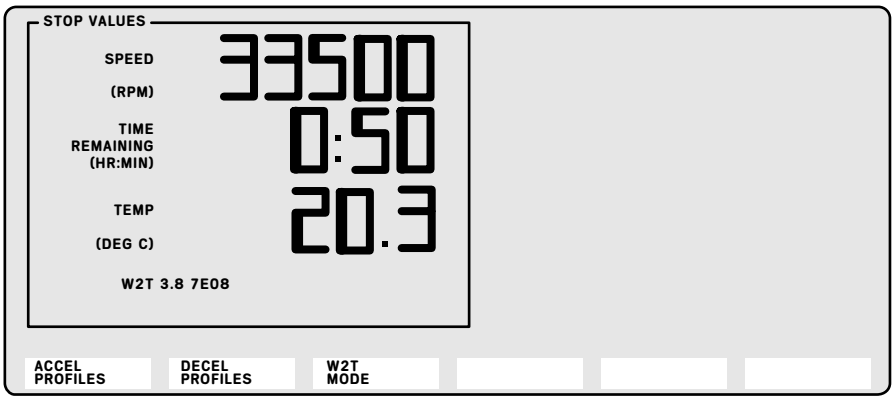


Figure 2-3. STOP VALUES Window

Checking the STOP VALUES can be helpful after a power outage or instrument shutdown to learn what the conditions were when the run was terminated.

NOTE

Pressing (STOP) during a run will cause the rotor to begin decelerating.

The STOP VALUES are retained in memory until a new run is started or instrument power is turned off.

SETTINGS WINDOW

The SETTINGS window shows the values entered for speed, time, temperature, acceleration and deceleration. The TIME display depends on the run-termination mode. In TIME mode, the display indicates the run time, in $\omega^2 t$ mode, it indicates the set $\omega^2 t$ value, and in HOLD mode, it shows the word "Hold." If a rotor has been selected for logging, the name of the rotor appears in the lower right corner. When in a programmed operation, the program number appears as part of the SETTINGS title bar at the top of the window. Figure 2-4 shows the default settings that appear when the instrument is turned on for the first time.

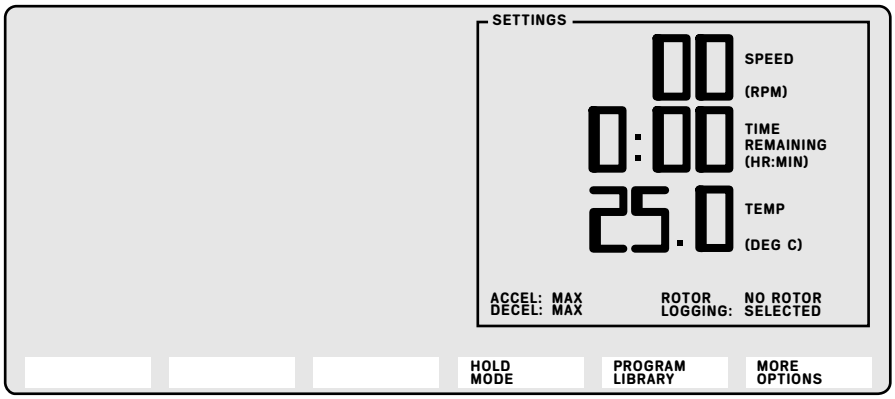


Figure 2-4. SETTINGS Window, Showing the Default Settings

OTHER SCREENS

The CURRENT VALUES window and/or the SETTINGS window will sometimes be temporarily replaced by other screens to complete a particular function (such as selecting acceleration or deceleration profiles), to access additional information (such as viewing the ROTOR CATALOG or ROTOR SPECIFICATIONS), or to access optional features (such as the ESP simulations). These other screens will be described in later sections.

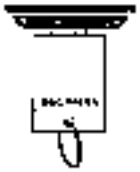
POWER

If the power is off, flip the circuit breaker at the right side of the instrument to on (up position). If in the standby mode, press any key to make the instrument fully operational.

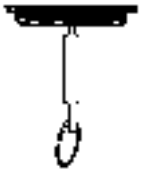
To end a run for any reason, press (STOP).

KEY SWITCH POSITIONS

Insert the key into the interlock switch on the control head (Figure 2-5) to select normal, locked, or zonal operation. The arrow on the key should point in the direction of the selected position. Icons for normal, locked, and zonal are displayed next to the interlock on the control head.



Turn the key to the right (clockwise) to the normal position for routine closed-door centrifugation. The key should be removed while in this position.



Keep the key inserted vertically to run the instrument in locked operation. The key should be removed while in this position.

Turn the key to the left (counterclockwise) to the zonal position for runs in which a zonal rotor is being used. The key cannot be removed while the instrument is running in a zonal operation.

NOTE

As a safety feature, after you press ENTER and START you must reset the key by turning it clockwise out of the zonal position and then back again into the zonal position. Then press ENTER and START again to begin the zonal run (see Section 8).

When the instrument is running in zonal or locked operation, “ZONAL” or “LOCKED” will appear in the lower right corner of the CURRENT VALUES window.

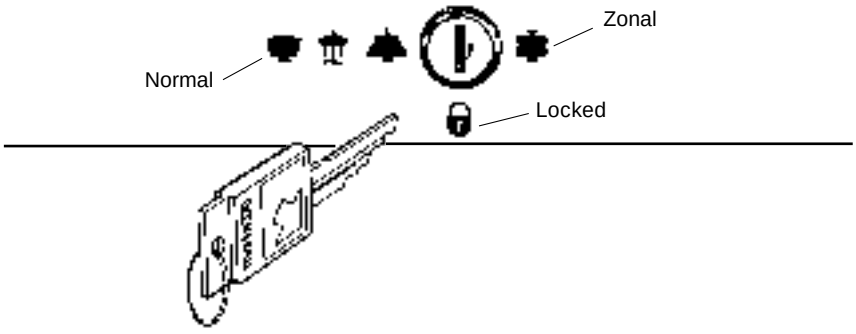


Figure 2-5. Inserting the Key into the Interlock Switch

ENTERING INFORMATION

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

- Press the appropriate hardkey or softkey 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.

KEYPAD

- Use the number keys, in sequence, to make numerical entries. As you enter each digit, those already entered move one place to the left in the display.
- Use the DECIMAL key as required when using the CALCULATIONS function (see Section 6).

(ce) (CLEAR ENTRY)

- Press *once* to clear a value while in the editing mode or to clear a diagnostic message.
- Press (ce) a second time to exit from editing mode. The field will stop blinking and the original value will be restored. Continue to press (ce) to step back through the menu tree, one screen at a time. (A few exceptions to this rule will be pointed out where they occur.)

(ENTER)

- Press (ENTER) to enter a setting into memory.
- Press (ENTER) and (START) to begin a run.

- Press ENTER and STOP to display the STOP VALUES— (the values that existed when the rotor began deceleration).

PARAMETER KEYS

The ROTOR hardkey is discussed briefly in this section as one of the parameter keys. See Section 4 for a full description of rotor functions.

SPEED HARDKEY

Run speed can be set between 1000 rpm and the instrument model's maximum speed, in increments of 100 rpm, and will be displayed in the SETTINGS window. Zero can be selected as the run speed in order to delay starting the run while maintaining the rotor at a specific temperature.

Actual rotor speed is displayed in the CURRENT VALUES window. Speeds between 0 and 1000 rpm are shown in increments of 10, speeds above 1000 rpm are shown in increments of 100.

To enter or modify the SPEED setting:

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.)
3. Check the SPEED setting. If the entry is incorrect, press CE once, and enter the correct value.
4. Press another parameter key or ENTER to save the run speed. If the value is valid, the SPEED field stops blinking.

You may change the speed setting at any time (except when the instrument is using ESP program settings or is in a locked operation). The rotor will accelerate or decelerate to the new speed accordingly.

At 1000 rpm the set speed is checked against the rotor's overspeed disk. If the speed setting is greater than that allowed by the overspeed disk, the run will continue uninterrupted, *but the rotor speed will be lowered to the maximum speed permitted by the disk*. A SPEED cautionary message will appear, indicating that this change was made.

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

At speeds between 15 000 and 20 000 rpm, rotor inertia is measured and the rotor energy is calculated for the set speed. If the calculated rotor energy is excessive, the instrument recalculates a maximum permitted set speed and uses this value to avoid possible rotor damage. A diagnostic message is displayed to indicate the change.

In certain circumstances, such as in continuous-flow centrifugation, you may want to begin the run at low speeds and then step the instrument up to higher speeds. If you have been running the rotor at between 15 000 and 20 000 rpm and then increase the set speed to above 20 800 rpm, *the instrument will decelerate to perform the inertia check before accelerating to the new set speed*.

If a speed-related malfunction occurs, the appropriate diagnostic message will appear on the screen. Follow the instructions on the screen and see the Troubleshooting Chart in Section 9.

(TIME) HARDKEY

How the run is terminated depends on the run mode—TIME, $\omega^2 t$, or HOLD.

Run time can be set for up to 999 hours and 59 minutes and will be displayed in the SETTINGS window. For runs under 99 minutes, you may enter the time in minutes and the instrument will automatically convert them to hours and minutes. The *time remaining in the run* is shown in the CURRENT VALUES window. When this value reaches zero, the run is ended.

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. Check the TIME setting. If the entry is incorrect, press (ce) once, and enter the correct value.
4. Press another parameter key or (ENTER) to save the run time. If the value is valid, the TIME field stops blinking.

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

The time begins counting down when the rotor begins to accelerate. (In a zonal run, the time does not begin counting down until the chamber door is closed after loading the rotor while spinning.) When the time remaining reaches zero, the rotor automatically decelerates to a stop.

You may change the time setting at any time except when the instrument is using ESP program settings or is in a locked operation.

ω²t MODE SOFTKEY

The $\omega^2 t$ display indicates the *accumulated centrifugal effect* in radians squared per second, to three significant digits, using exponential notation. The $\omega^2 t$ can be set for up to 9.99×10^{14} radians squared per second. When the instrument is powered up for the first time, the default setting when in that mode is 0.00E00.

The $\omega^2 t$ begins accumulating when ENTER and START have been pressed and the rotor begins spinning; deceleration begins when the set value is reached. The value displayed in the lower left corner of the CURRENT VALUES window represents the total centrifugal effect on the sample thus far. (In a sequential program, the $\omega^2 t$ value represents the cumulative centrifugal effect on the sample from all completed steps of the run.) At the end of the run, this value represents the total centrifugal effect on the sample when the rotor began decelerating to a stop.

In $\omega^2 t$ mode, the value for TIME in the CURRENT VALUES window is the *calculated time remaining* until the set $\omega^2 t$ is reached. This value is automatically computed after speed and $\omega^2 t$ values have been entered.

To enter or modify the $\omega^2 t$ value:

1. Press the ω²t MODE softkey. The $\omega^2 t$ field (temporarily replacing the TIME setting) blinks. (Pressing TIME will restore the TIME settings.)

2. Use the keypad to enter or modify the $\omega^2 t$ value. An “E” remains stationary in the hundreds place to indicate that the last two places represent the $\omega^2 t$ exponent. (There is no need to use the decimal point key when entering this value.)

3. Check the $\omega^2 t$ setting. If the entry is incorrect, press CE and enter the correct value.

4. Press another parameter key or ENTER to save the $\omega^2 t$ value. If the value is valid, the $\omega^2 t$ field stops blinking.

The accumulated $\omega^2 t$ from the previous run will be cleared automatically when ENTER and START are pressed to begin a new run.

The set speed is checked against the rotor's overspeed disk at 1000 rpm. If the speed setting is greater than that allowed by the overspeed disk, the run will continue uninterrupted, but the rotor speed will be lowered to the maximum speed permitted by the disk. The time remaining is also recalculated to ensure that the $\omega^2 t$ value is reached. (There may be a brief lag in displaying the recalculated time.) A cautionary message will appear, indicating that these changes were made.

HOLD MODE SOFTKEY

The HOLD mode is used for runs of unspecified lengths. The time displayed in the CURRENT VALUES window is the time elapsed since the run began.

To select the HOLD mode:

1. Press the HOLD MODE softkey. The word "Hold" appears in the TIME field of the SETTINGS window and zeros appear in that field in the CURRENT VALUES window.
2. Press the next parameter key or ENTER.

The run will continue indefinitely until you press STOP to end it. Time elapsed will continue to accumulate until the rotor stops. The accumulated $\omega^2 t$ value for the run is displayed in the lower left corner of the CURRENT VALUES window.

TEMP (TEMPERATURE) HARDKEY

The run temperature, which can be set between 0 and 40°C in increments of 1°C, is displayed in the SETTINGS window.

To enter or modify the TEMP setting:

1. Press TEMP. The TEMPERATURE field blinks.
2. Use the keypad to enter or modify the temperature.
3. Check the TEMPERATURE setting. If the entry is incorrect, press CE and enter the correct value.
4. Press another parameter key or ENTER to save the set temperature. If the value is valid, the TEMPERATURE field stops blinking.

You may change the temperature setting at any time except when the instrument is using ESP program settings or is in a locked operation. The rotor temperature will be adjusted accordingly.

Actual rotor temperature, after equilibration, is controlled to ±0.5°C of the set value. If the temperature control system malfunctions, the appropriate diagnostic message will appear and the rotor will automatically decelerate to a stop. Follow the instructions on the screen and see the Troubleshooting Chart in Section 9.

ACCEL PROFILES SOFTKEY

Maximum acceleration and nine slow acceleration profiles are available to minimize disturbing the sample and sample-to-gradient interface. The selected ACCEL entry is displayed in the lower left corner of the SETTINGS window; MAX is the default setting.

Slow acceleration profiles are listed by number, including transition speeds and times, in the ACCELERATION PROFILES window (Figure 2-6). The rotor speeds indicate the speed at which the rotor completes its slow acceleration, at which point the rotor accelerates at maximum speed to set speed. MAXIMUM ACCEL appears as a softkey at the bottom of the screen.

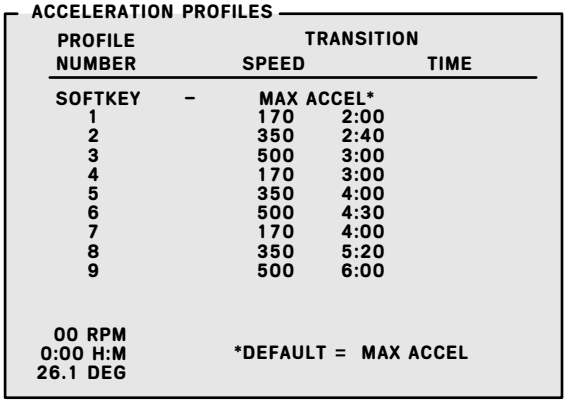


Figure 2-6. ACCELERATION PROFILES Window

To select an ACCEL profile:

1. Press the ACCEL PROFILES softkey. The ACCEL field blinks in the lower left corner of the SETTINGS window, and the ACCELERATION PROFILES window appears, temporarily replacing the CURRENT VALUES window.

2. Use the keypad or softkeys to select an acceleration profile.

3. Press another parameter key or (ENTER). The ACCEL field in the SETTINGS window stops blinking and the selected profile is displayed.

(DECEL PROFILES) SOFTKEY

Maximum deceleration, nine slow deceleration profiles, and a "no brake" option are available to minimize disturbing the sample and sample-to-gradient interface. The DECEL entry is displayed in the lower left corner of the SETTINGS window; MAX is the default setting.

Slow deceleration profiles are listed by number, including transition speeds and times, in the DECELERATION PROFILES window (Figure 2-7). The rotor speeds indicate the speed at which the rotor begins its slow deceleration. (Until that point the rotor decelerates with full dynamic braking.) (MAXIMUM DECEL) and (NO BRAKE) appear as softkeys at the bottom of the screen.

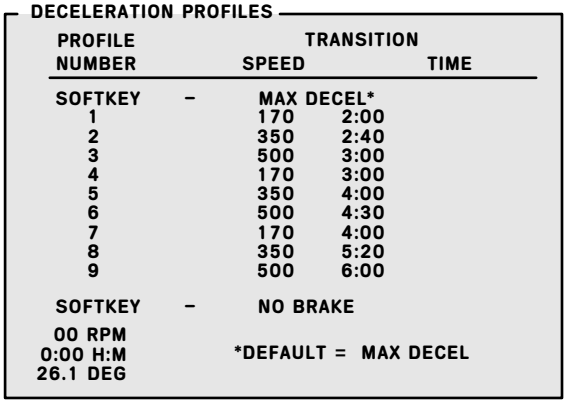


Figure 2-7. DECELERATlON PROFILES Window

To select a DECEL profile:

1. Press the (DECEL PROFILES) softkey. The DECEL field blinks and the DECELERATION PROFILES window appears, temporarily replacing the CURRENT VALUES window.

2. Do one of the following:

   Press the MAXIMUM DECEL softkey for maximum deceleration. Then press ENTER or another parameter key to continue.

   or

   Use the keypad or arrow softkeys to select a deceleration profile, then press ENTER or another parameter key to continue.

   or

   Press the NO BRAKING softkey for a stop without using the brake. Then press ENTER or another parameter key to continue.

The selected DECEL entry is displayed in the lower left corner of the SETTINGS window.

ROTOR HARDKEY

The ROTOR hardkey accesses several rotor functions. Selecting a rotor for logging is discussed here; Section 4 describes other rotor functions.

When a specific rotor (from the LAB ROTORS list) is selected for logging, the total runs and hours are automatically updated in the log at the end of the run, providing a simple method for keeping rotor usage records current.

The ROTOR LOGGING field appears in the lower right corner of the SETTINGS window.

To select a rotor for logging:

1. Press ROTOR. The ROTOR LOGGING field blinks in the SETTINGS window and the Lab Rotors log appears, temporarily replacing the CURRENT VALUES window.

2. If the rotor in use does not appear on this screen, press the NEXT PAGE softkey until you find it in the list. (You can include up to 40 rotors in the LAB ROTORS log, listed in sets of 10 on each page.) Use the keypad to select a rotor by line number.

3. Press ENTER. The Main Screen reappears; the ROTOR LOGGING field stops blinking and the rotor number and model are displayed in the lower right corner of the SETTINGS window.

The rotor entry cannot be changed while the run is in progress; you may select NO ROTOR LOGGING, however, if you do not want the run logged to that specific rotor.

When the run ends, the hours and runs for the rotor in use are updated in the LAB ROTORS log. The ROTOR LOGGING field is cleared and the default NO ROTOR SELECTED is displayed until the next rotor entry is made.

ACTIVATION KEYS

NOTE

The (PRINTER) hardkey is mentioned only briefly in this section; see Section 5 for a detailed description of printer functions.

(START)

Press (ENTER) and (START) to begin a run. The instrument checks for a setting in the TIME field. (The instrument cannot operate without a TIME entry.) If no TIME entry exists, an error tone sounds and the field blinks. Press (TIME) or ($\omega^2 t$ MODE) and enter a value, or press (HOLD). Then press (ENTER) and (START) again to begin the run.

The vacuum system is automatically activated at this time if (VACUUM) was not pressed in advance. The appropriate run status messages appear in the CURRENT VALUES window to indicate the progress of the run.

(STOP)

Press (STOP) at any time to terminate a run.

Press (ENTER) and (STOP) to temporarily display the STOP VALUES in place of the CURRENT VALUES (see Figure 2-3). These are the conditions that existed when the rotor began decelerating (because (STOP) was pressed, the run was over, or the run was ended due to an instrument malfunction). The CURRENT VALUES window returns automatically after 5 seconds. The STOP VALUES are retained in memory until a new run is started or instrument power is turned off.

(VACUUM)

When the vacuum system is on, the chamber pressure is displayed in microns in the lower left corner of the CURRENT VALUES window. (OFF is shown

when the system is off.) 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.

The vacuum system is activated automatically when you select PRECOOL or PREHEAT as well as when you press ENTER and START to begin a run. To evacuate the chamber before the run, however, make sure the chamber door is closed, then press VACUUM. (See Section 8 for instructions on activating the vacuum system in the zonal operating mode.)

The chamber door can be opened only when the vacuum has been completely vented and the rotor is at rest (except during zonal operation).

If a vacuum-related malfunction occurs, a diagnostic message appears and the instrument shuts down. Follow the instructions on the screen and see the Troubleshooting Chart in Section 9.

PRINTER

Press the PRINTER hardkey to access the PRINTER menu window, which appears on the right side of the screen. Select the required function from the menu as prompted. See Section 5 for information on each of the printer functions.

MORE OPTIONS

Press the MORE OPTIONS softkey to access additional system features. The new softkeys provide access to the Calculations (Section 6) and ESP™ Efficient Sedimentation Program (Section 7) options.

PRECOOLING AND PREHEATING THE ROTOR

The Optima XL provides a convenient means of precooling or preheating the rotor in the chamber in a partial vacuum; also, the radiometer senses the rotor temperature and continually adjusts the chamber temperature to expedite reaching the set temperature.

When you press PRECOOL or PREHEAT, the vacuum system is activated automatically. The temperature setting is automatically set at 4°C or 37°C; these settings can be changed. To end precooling or preheating the rotor, press VACUUM to vent the chamber.

3

Programmed Runs

The Optima XL can store up to ten programs in the Program Library: nine standard (single-step) programs and one sequential program, which can have up to five steps. The programs are stored in memory (even with the power off) until called up by number for use or modification.)

STANDARD PROGRAMS

Press the PROGRAM LIBRARY softkey at the Main Screen to access the PROGRAM LIBRARY and SETTINGS windows (Figure 3-1).

Default settings are displayed in the program lines until program settings are entered. In the SETTINGS window; PROGRAM NO. _ is displayed, blinking, in the title bar.

Each program includes program (PROG) number, run speed, run mode (time, $\omega^2 t$, or Hold), run temperature, and acceleration and deceleration profiles. It does not include selecting a particular rotor for logging.

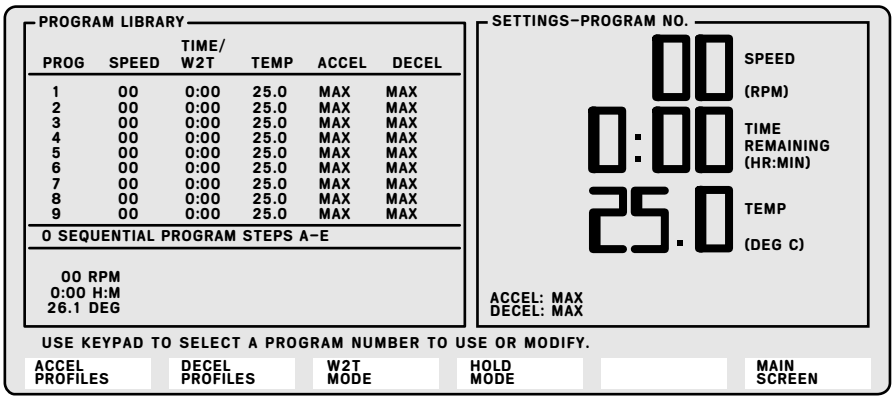


Figure 3-1. PROGRAM LIBRARY and SETTINGS Windows

The softkey labels at the bottom of the screen change according to the PROGRAM LIBRARY function in process.

CREATING OR MODIFYING A STANDARD PROGRAM

To create or modify a standard program, do the following.

1. Press (PROGRAM LIBRARY).
2. Use the keypad to select a PROG number. Do not press (ENTER). The selected program line will be highlighted and the program number will replace the dash in the SETTINGS title bar, which continues to blink. The settings that appear on the program line are displayed in the SETTINGS window.
3. Enter the program values — speed, run mode, temperature, and acceleration and deceleration profiles—as described in Section 2.
4. Press (SAVE PROGRAM) to save the settings as a program. The values are displayed both on the program line and in the SETTINGS window. The title bar will continue to blink to indicate that you have not yet selected this program for use.
5. Press (ENTER) to select the program settings for use. (Press (MAIN SCREEN) instead if you are not running the program at this time.)
6. Select a rotor for logging (if required) and press (ENTER). Then press (ENTER) and (START) to begin the programmed run.

USING AN EXISTING PROGRAM

To select a previously defined program from the Program Library, do as follows.

NOTE

If a program has been loaded into the SETTINGS window but has not been run, it must be cleared before another program can be selected. If necessary, press (CE) to clear the program, then continue with the instructions below.

1. Press the PROGRAM LIBRARY softkey.
2. Use the keypad to select a program by number and press ENTER. You will be returned to the Main Screen, with the selected program settings displayed in the SETTINGS window (Figure 3-2).
3. Select the rotor for logging (if required).
4. Press ENTER and START to begin the programmed run.

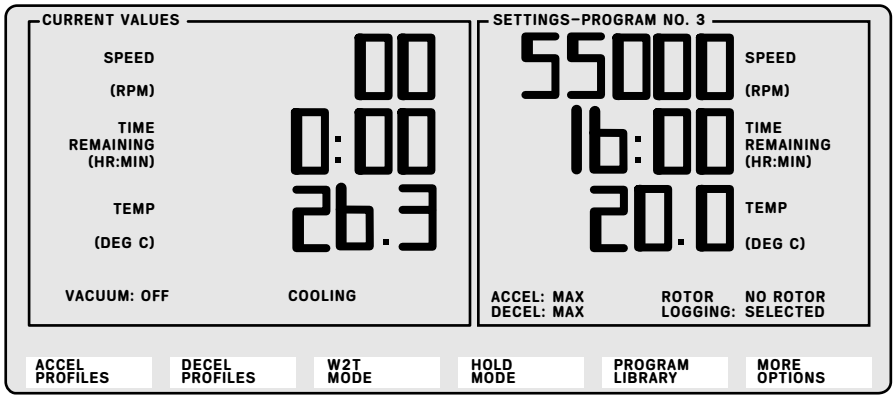


Figure 3-2. Entering an Existing Program for Use

SEQUENTIAL PROGRAM

A sequential program is available as a tenth program (labeled “0”) in the PROGRAM LIBRARY (see Figure 3-1). It is used to link up to five sets of run conditions together as *steps in one larger procedure*. This is useful if you want to change parameters, such as speed, during a run. The steps are labeled A through E to prevent confusing sequential program steps with standard program numbers. Softkey labels at the bottom of the screen will change as required.

When SEQUENTIAL PROGRAM is selected, a list of program *steps* is displayed in the left window; settings for Step A are shown in the right window (Figure 3-3). Default settings are displayed in this window if no values for Step A have been entered.

When running in the $\omega^2 t$ mode, the $\omega^2 t$ value displayed in the CURRENT VALUES window represents the *total accumulated centrifugal effect for all steps completed*.

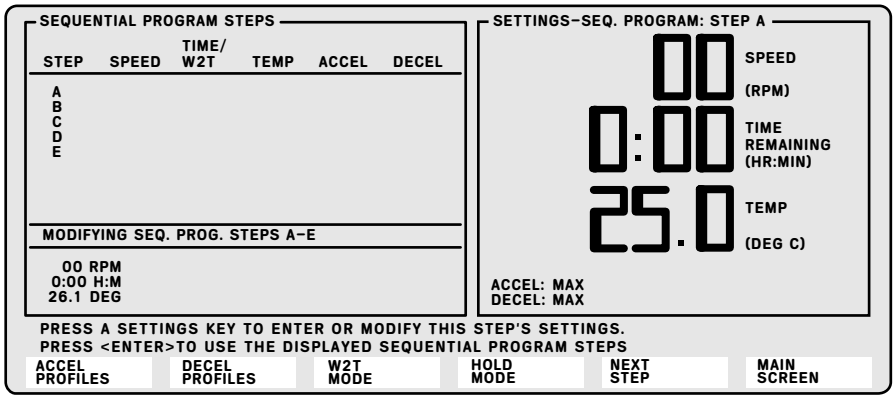


Figure 3-3. SEQUENTIAL PROGRAM Windows

CREATING A SEQUENTIAL PROGRAM

Create a sequential program as follows:

1. If necessary, press (ce) to clear any program settings displayed on the Main Screen before proceeding.

2. Press (PROGRAM LIBRARY).

3. Press (0) to select SEQUENTIAL PROGRAM. (Do not press (ENTER).) The list of program *steps* appears in the left window; settings for Step A are shown in the right window. The SETTINGS title bar blinks in reverse video to indicate that you are editing Step A.

4. Enter program settings for Step A. The new values appear in the SETTINGS window but *not* on the sequential program line (see Figure 3-4).

NOTE

HOLD should be used *only* in the last step. If you select HOLD in an earlier step, the instrument cannot go to the next step, preventing the completion of later steps.

Also, to use slow acceleration and deceleration rates, select a slow ACCEL profile for Step A or for the first step only, if Step A is 0 speed (delayed start), and a slow DECEL profile for the last step only. (Slow acceleration and deceleration profiles are meaningless in the intermediate steps.)

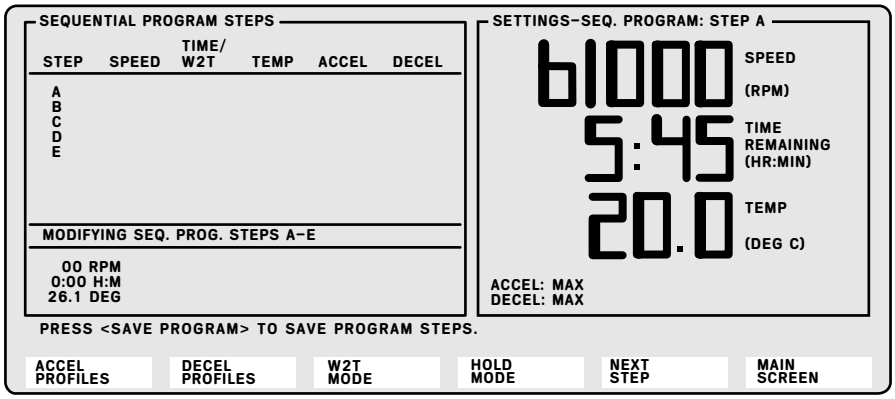


Figure 3-4. Entering Settings for Step A

5. Press (SAVE PROGRAM) to save Step A. The settings are displayed in the SETTINGS window *and* on the program line.

6. Press (NEXT STEP) to move to Step B. Enter and save the settings as described above. (You must press (SAVE PROGRAM) to save *each* step.) Then press (NEXT STEP) again to move to Step C. Repeat the process until you have entered and saved all steps required. Remember, you may enter one to five sets of run conditions but you must enter them in sequence. For example, you cannot leave Step B blank and enter settings for Step C.

7. To load the completed sequential program, press (ENTER). Current values will be displayed in the left window and settings for SEQ. PROGRAM: STEP A will be displayed in the SETTINGS window.

   To exit from the screen without loading the program, press (MAIN SCREEN) and the system will return to the Main Screen. Your settings have been saved but they are not displayed at this time.

8. Select a rotor for logging (if required).

9. Press (ENTER) and (START) to begin the sequential program. As each step is in progress, the appropriate settings are displayed in the SETTINGS window. The title bar indicates the step in progress.

MODIFYING STEPS IN A SEQUENTIAL PROGRAM

The steps in a sequential program can be modified or deleted as follows. (Run settings for ESP sequential programs cannot be changed.)

1. If necessary, press (ce) to clear program settings from the Main Screen before proceeding.
2. Press (PROGRAM LIBRARY).
3. Press (0) to select SEQUENTIAL PROGRAM. If necessary, press (NEXT STEP) one or more times to highlight the step to be modified.
4. Use the setting keys and keypad to make the changes, then press (ENTER). Press (SAVE PROGRAM) to save this step.
5. Continue this process until the steps are modified as required, pressing (SAVE PROGRAM) *with each* step modified.
6. To use the modified sequential program, press (ENTER) and (START). To exit the program without using it, press (MAIN SCREEN) *instead* of pressing (ENTER).

DELETING A STEP

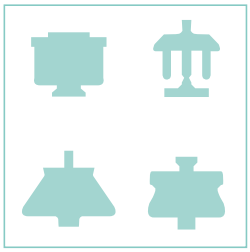
To delete an entire step instead of modifying it, follow these instructions.

1. If necessary, press (ce) to clear program settings from the Main Screen before proceeding.
2. Press (PROGRAM LIBRARY).
3. Press (0) to select SEQUENTIAL PROGRAM. If necessary, press (NEXT STEP) one or more times to highlight the step to be deleted.
4. Press (ce). You will be asked whether you want to delete the current step.
5. To delete the step, press the (YES) softkey. The settings disappear, and any steps that follow are moved up a line. For example, if you deleted Step C in a program of five steps, Steps D and E would become Steps C and D.

   If you decide not to delete the step, press the (NO) softkey. (Pressing (ce) has the same effect as pressing (NO).)
6. To use the modified program, press (ENTER) and (START). To exit the program without loading it for immediate use, press (MAIN SCREEN) instead of pressing (ENTER).

4

Rotor Functions



A variety of rotor software functions can be accessed with the (ROTOR) *hardkey, including rotor logging, accessing the ROTOR CATALOG, and viewing specifications of individual rotors. For detailed information on the rotors used in the Optima XL, refer to the individual rotor manuals.*

LAB ROTORS LOG

The LAB ROTORS log enables accurate record keeping of rotor use. The Optima XL can update the information for each rotor in the log each time the rotor is used. You can also enter the information manually if the rotor has been used in another ultracentrifuge.

NOTE

Although rotor logging and deration are no longer required for warranty purposes, Beckman Coulter recommends that you continue to log rotor usage, as this information is helpful to Field Service technicians if rotor repair is necessary. Also, your laboratory standard operating procedures may require rotor logging and deration.

LAB ROTORS AND SETTINGS WINDOWS

Press the (ROTOR) hardkey while you are at the Main Screen. The LAB ROTORS window will appear on the left side of the screen.

Ten rotors can be displayed in the window at a time; a total of 40 rotors can be entered in the log.

A reverse video bar moves up and down the list to highlight the selected rotor. The first line of the log, labeled 00 NO ROTOR LOGGING, is a permanent entry. Select this entry when you do not want the rotor information logged to a specific rotor.

When you press the (ROTOR) hardkey, the ROTOR LOGGING field of the SETTINGS window blinks to indicate that you can enter a rotor selection.

SOFTKEYS

The softkey labels that appear when the LAB ROTORS window is accessed are listed below; these will change, as required by the particular rotor function. The softkeys have the following functions:

(NEXT PAGE)	Displays the next page (screen) of lab rotors; each page lists 10 rotors.
(ADD ROTOR)	Allows you to add a rotor to the list of lab rotors.
(SHOW SPECS)	Displays specifications of the rotor selected for logging. (This softkey is not available if no rotor is selected.)
(MODIFY INFO)	Allows you to modify rotor information.
(ROTOR CATALOG)	Allows you to access the list of Beckman Coulter rotors and rotor specifications.
(MAIN SCREEN)	Returns you to the Main Screen.

ADDING A ROTOR

Add a rotor to your LAB ROTORS log as follows:

1. While at the LAB ROTORS window, press the (ADD ROTOR) softkey.
2. Use the keypad to select a rotor line number (a number between 1 and 40) to indicate where the rotor will appear in the log. (Each page shows ten rotors.) The selected number will appear in the field just below the list. Press (ENTER).
3. Use the arrow softkeys to highlight the name of the rotor to be added from the ROTOR CATALOG window, which appears on the right side of the screen (see Figure 4-1). Press (ENTER). The rotor model and maximum speed permitted automatically appear in the appropriate fields of the log.

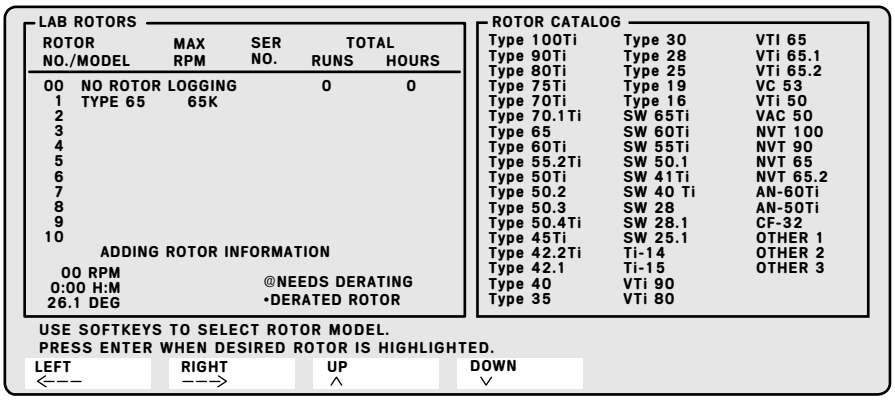


Figure 4-1. Adding a Rotor to the LAB ROTORS Log

4. For rotors that may require derating, answer the question: “Is this a derated rotor,” using the (YES) or (NO) softkey. If you answer NO, the serial number field begins to blink. If you answer YES, respond to the prompt to enter the derated maximum speed using the keypad. Press (ENTER). The derated speed replaces the maximum speed; an asterisk following the value indicates that the rotor speed has been derated.

NOTE

As you are entering information into the log, use the (PREVIOUS FIELD) and (NEXT FIELD) softkeys to move back and forth between fields if necessary. When you press (NEXT FIELD), the default value appears in the field; replace it with an appropriate value as required.

5. Use the keypad to enter the rotor serial number. (If the serial number begins with a letter, such as A1221, enter *only* the four numerical digits.) Press (ENTER).

6. Use the keypad to enter or modify the total number of runs that the rotor has made (in this and any other ultracentrifuge). Press (ENTER).

7. Use the keypad to enter or modify the total number of hours that the rotor has run (in this and any other ultracentrifuge). Press (ENTER).

The softkey labels will change as shown in Figure 4-2, indicating that all necessary information has been entered.

To save the information just entered and return to the LAB ROTORS window, press the (SAVE AND EXIT) softkey. Once saved, you cannot modify the rotor model or serial number without deleting the rotor entirely from the log and re-entering the rotor to the list. To exit without saving the information, press the (EXIT—NO SAVE) softkey.

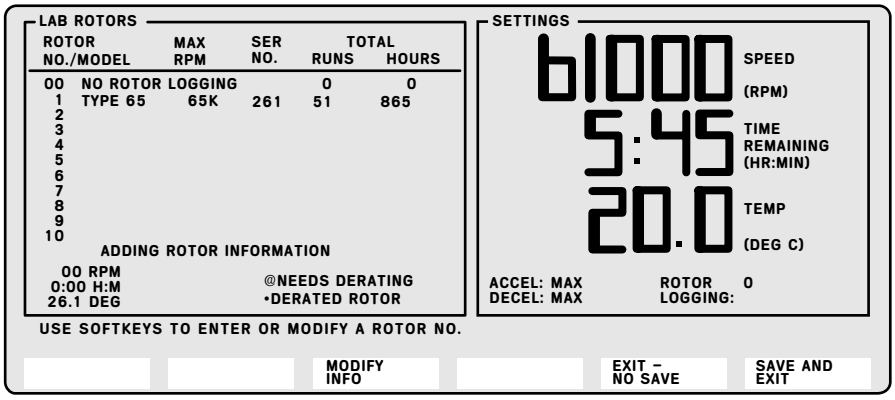


Figure 4-2. Saving the Rotor Information in the LAB ROTORS Log

NOTE

This procedure *saves* the rotor information but *does not select this rotor for logging*. This is a separate operation so the default "0" continues to blink in the ROTOR field of the SETTINGS window. Selecting a rotor for logging is discussed later in this section.

ADDING AN "OTHER" ROTOR TO THE LAB ROTORS LOG

If you purchase a new rotor that does not appear in the ROTOR CATALOG, you can add it to your list of lab rotors by calling it OTHER.

1. While at the LAB ROTORS window, press the (ADD ROTOR) softkey.
2. Use the keypad to select a rotor line number. The selected number will appear in the field just below the list. Press (ENTER).
3. Use the arrow softkeys to highlight one of the six OTHER entries (such as OTHER1) from the ROTOR CATALOG window. Press (ENTER). The entry will appear in the ROTOR MODEL field.
4. Use the keypad to enter the rotor's maximum permitted speed. Press (ENTER).
5. Use the keypad to enter or modify the total number of runs that the rotor has made (in this and any other ultracentrifuge). Press (ENTER).

6. Use the keypad to enter or modify the total number of hours that the rotor has run (in this and any other ultracentrifuge). Press (ENTER).

You can use each OTHER entry only once. If you try to list it a second time, an error message will indicate that this entry has already been selected.

SELECTING A ROTOR FOR LOGGING

1. Press the (ROTOR) hardkey.
2. If necessary, press (NEXT PAGE) to scroll to the rotor on the list, then use the keypad to select it by rotor number. The rotor line number and the rotor model name will blink in the ROTOR field of the SETTINGS window.
3. Press (ENTER).

When the run ends, the instrument automatically updates the LAB ROTORS log to include this run (total runs and hours). The ROTOR field in the SETTINGS window is cleared and NO ROTOR SELECTED is again displayed.

MODIFYING INFORMATION IN THE LAB ROTORS LOG

This feature allows you to modify certain information in the LAB ROTORS log, including deleting a rotor and adding runs and hours to the log.

DELETING A ROTOR

Delete a rotor from the LAB ROTORS log as follows.

1. Press the (ROTOR) hardkey. If necessary, press (NEXT PAGE) to scroll to the rotor.
2. Press (MODIFY INFO).
3. Press (DELETE ROTOR).
4. Use the keypad to select the rotor to be deleted and press (ENTER).
5. Respond to the prompt “Do you really wish to delete rotor no. x?” Press (YES) to delete the selected rotor; press (NO) to return to the LAB ROTORS window without deleting the rotor.

MANUALLY ADDING RUNS AND HOURS

This feature lets you update the total number of runs and hours in the LAB ROTORS log, such as including data for a rotor run in another ultracentrifuge. You can only *add* runs and hours however—you cannot reduce the number of runs or hours or change the rotor serial number.

1. Press the (ROTOR) hardkey. If necessary, press (NEXT PAGE) to scroll through the rotor.
2. Press (MODIFY INFO).
3. Press (ADD RUNS AND HOURS).
4. Use the keypad to select the rotor. Press (ENTER).
5. Use the keypad to update the total number of runs. Press (ENTER).
6. Use the keypad to update the total number of hours. Press (ENTER).
7. Press the (SAVE AND EXIT) softkey to save the information and return to the LAB ROTORS window. Press (EXIT—NO SAVE) to cancel the change.

ROTOR CATALOG AND ROTOR SPECIFICATIONS

The ROTOR CATALOG window lists all available Beckman Coulter ultracentrifuge rotors at the time of the Optima XL software release. New versions of the software, which include updated catalogs of available rotors, are released periodically. (Contact your Beckman Coulter representative for information on obtaining new software versions.)

ROTOR SPECIFICATIONS provides information on the rotors listed in the catalog. This data is contained within the instrument internal database and cannot be modified by the user. The specifications include model name, maximum rated speed, instrument class, *k* factor at maximum speed, information on minimum, average, and maximum radial distances, and RCF values at maximum speed. It also lists nominal tube and rotor volumes, number of tubes the rotor can hold, and tube angle. The specific kind of information presented may vary, depending on the category of rotor selected. For example, specifications for a zonal rotor will differ from those of a swinging bucket rotor. Information not included on the ROTOR SPECIFICATIONS window can be found in the individual rotor manuals, *Rotors and Tubes for Preparative Ultracentrifuges* (LR-IM), or the *Ultracentrifuge Rotors, Tubes, & Accessories* catalog (BR-8101). The ROTOR SPECIFICATIONS screen also provides information on tubes associated with each rotor. Therefore, ROTOR SPECIFICATIONS information will vary depending on the rotor/tube combination.

Press ROTOR while you are at the Main Screen to access the LAB ROTORS window. Then press the ROTOR CATALOG softkey to access the ROTOR CATALOG window, which appears on the right side of the screen (see Figure 4-3).

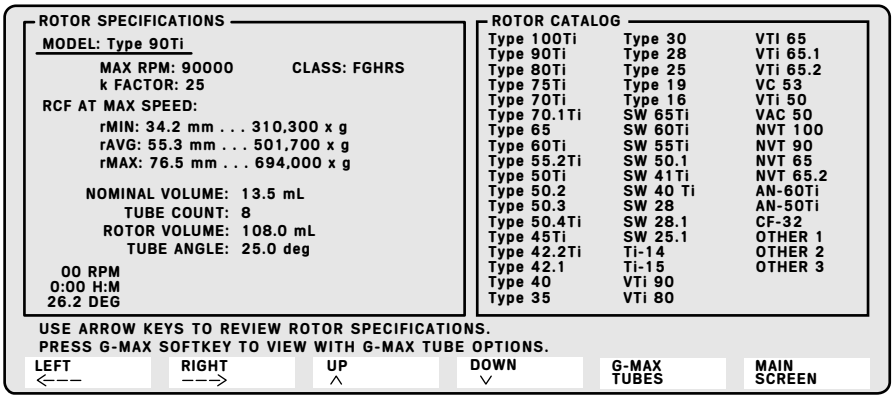


Figure 4-3. The ROTOR CATALOG and ROTOR SPECIFICATIONS Windows

VIEWING ROTOR SPECIFICATIONS

1. Press the arrow softkeys at the bottom of the screen to highlight a rotor in the catalog.

2. As a specific rotor is highlighted, the specifications for that rotor appear in the window on the left. You can browse through the catalog rotors for required rotor specifications. Figure 4-3 shows the specifications for the Type 90 Ti rotor.

3. Press MAIN SCREEN to return to the Main Screen.

VIEWING ROTOR AND TUBE SPECIFICATIONS

1. Press the G-MAX TUBES softkey while you are in the ROTOR CATALOG window.

2. The G-MAX TUBES window will appear on the right side of the screen. Press the appropriate arrow softkeys to highlight a tube in the catalog.

NOTE

The full-size tube is always given as first in the list and is not a *g*-Max tube.

3. When a specific tube is highlighted, the specifications for that rotor/tube combination appear in the window on the left. Figure 4-4 shows the specifications for the Type 90 Ti rotor with a 6.5 mL tube.

4. Press (MAIN SCREEN) to return to the Main Screen or (ROTOR CATALOG) to return to the ROTOR CATALOG window.

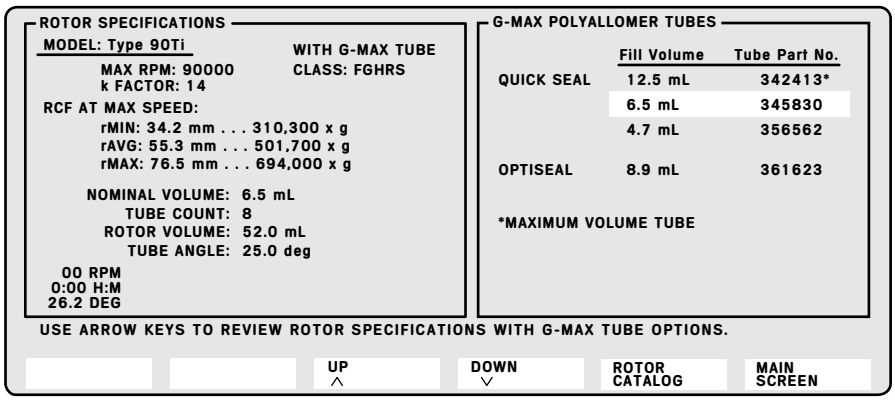
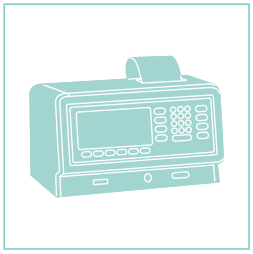


Figure 4-4. Selecting a Tube for Rotor and Tube Specifications

5

The Printer



This section describes use of the built-in printer that provides a variety of instrument and run data printouts. See Section 9 for information on the care of the printer, including changing the paper and ribbon.

PRINTER MENU WINDOW

Press the (PRINTER) hardkey to access the PRINTER window shown in Figure 5-1. This window temporarily replaces the SETTINGS window on the right side of the screen. Status information appears at the top of the window. A printing functions menu is in the center of the window, and setup information is at the bottom of the screen.

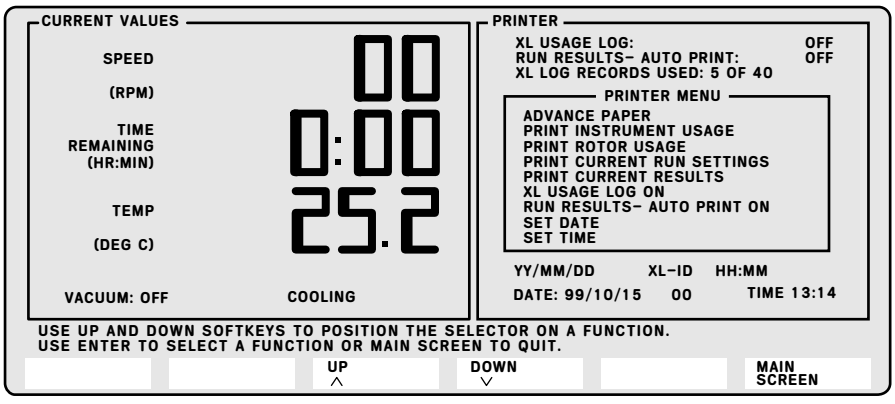


Figure 5-1. PRINTER Menu Window

STATUS INFORMATION

Status information will be displayed at the top of the window as follows, *depending on the selections made from the printer menu*.

- XL Usage Log—Indicates whether instrument usage logging is ON or OFF. *Be sure to have this ON if you intend to print out the usage records at a later time*.
- Run Results-Auto Print—Indicates whether automatic printing of the run results is ON or OFF.
- XL Log Records Used—Indicates how many log records have been used from the 40 available records.

SETUP INFORMATION

When the current date and time are entered, they are automatically updated and displayed at the bottom of the window. The instrument ID number is also displayed.

MENU OPTIONS

The printer menu lists available printer-related functions. Press the (UP) and (DOWN) softkeys to scroll up and down the menu to highlight your selection. (Not all of the options may fit on the screen at once.) Press (ENTER) to select the highlighted entry or (MAIN SCREEN) to exit and return to the Main Screen.

ADVANCE PAPER

Select **Advance Paper** and press (ENTER) to advance the printer paper. Each time you press (ENTER), the paper advances six lines. (The roll of paper will begin showing a red stripe at the edge when it is almost used up.)

PRINT INSTRUMENT USAGE AND PRINT ROTOR USAGE

These are two separate logs, each with the capacity to store 40 records. The maximum length of a "page" for either printout is eight inches. If the list of records is more than a page long, subsequent pages are printed as required.

NOTE

It is important to print out *each* log regularly since printing clears the records for reuse. If a printout is not requested, the entries continue to be logged until the log is full—there is room for 40 records at a time. When within five records of the maximum, a message warns that the log is almost full. When entry 40 is used, a diagnostic message notes that no subsequent entries will be logged until the log is printed and cleared for reuse.

Instrument Usage

Select **Print Instrument Usage** and press ENTER for a printout of recent instrument usage (see Figure 5-2).

Each Instrument Usage Record includes the date of the run, rotor used, rotor serial number, the maximum speed reached (in thousands of rpm), and total run time. A sequential run (having several steps) is considered one run—the maximum speed and total run time for all steps is given.

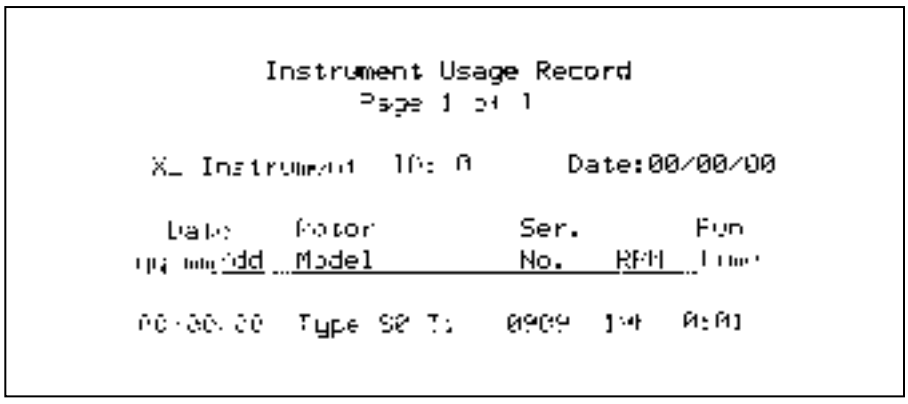


Figure 5-2. Sample Printout of Instrument Usage

Rotor Usage

Select **Print Rotor Usage** and press ENTER for a printout of rotor usage (see Figure 5-3).

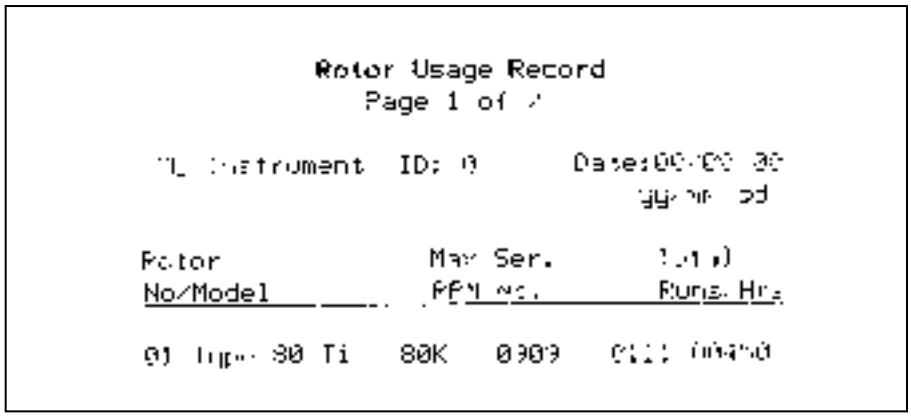


Figure 5-3. Sample Printout of Rotor Usage

Each Rotor Usage Record includes the rotor line number (from the list of lab rotors) and model name, maximum rotor speed, rotor serial number, total number of runs, and total hours run. (A run is considered valid if the rotor accelerated beyond 3000 rpm.) A line is provided at the end of the record for the signature of the operator who updates the records.

PRINT CURRENT RUN SETTINGS

Select **Print Current Run Settings** and press ENTER for a printout of the current settings.

The record of run settings includes speed, time, temperature, accel and decel profile numbers, and the $\omega^2 t$ value (including exponent). The name and serial number of the rotor are provided at the bottom of the printout. If the printout is of a sequential run, all steps are printed out on the same record (see Figure 5-4).

PRINT CURRENT RUN RESULTS

Select **Print Current Run Results** and press ENTER for a printout of the results of the present run.

The record of run results includes speed, time, temperature, accel and decel profile numbers, and the $\omega^2 t$ value (including exponent). The name and serial number of the rotor follow the results, as well as a place for the operator to fill in the tube size. If the printout is of a sequential run, all steps are printed out on the same record (see Figure 5-5).

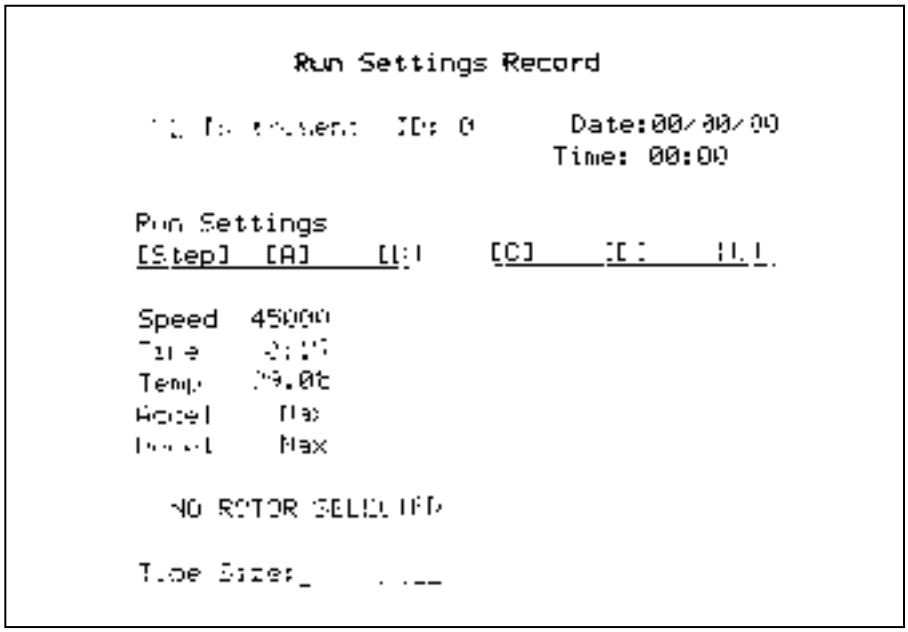


Figure 5-4. Sample Printout of Current Settings

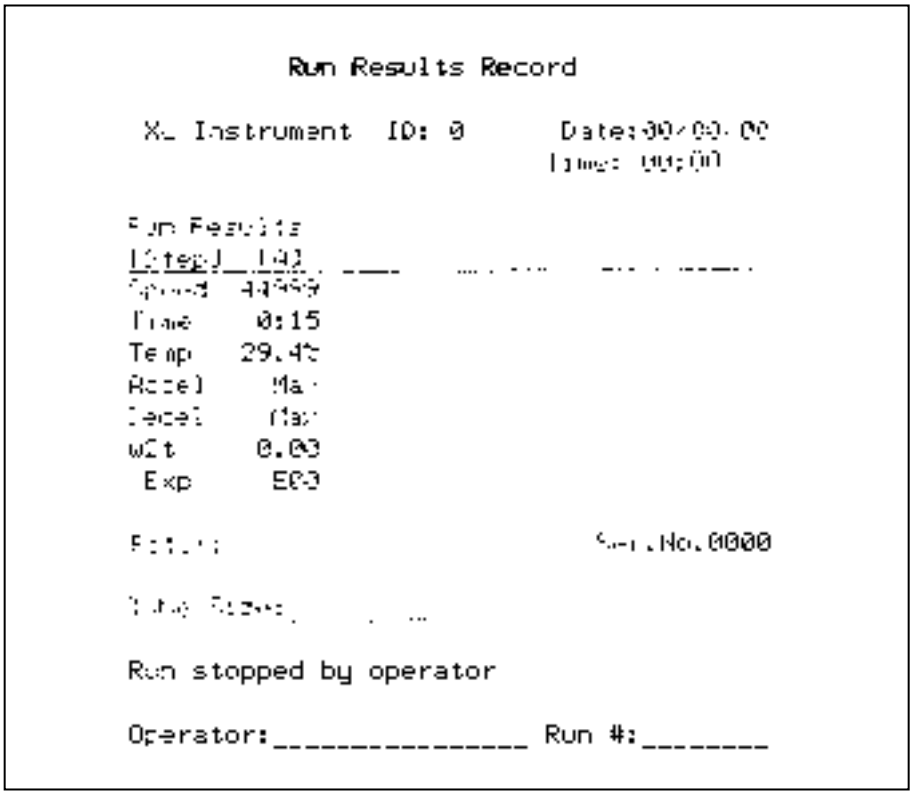


Figure 5-5. Sample Printout of Current Run Results

A line beneath the tube size indicates the manner in which the run was terminated.

- Run completed.
- Run stopped by operator.
- Run stopped by diagnostic xx (actual diagnostic number is provided).

At the end of the record there are places for the operator to sign the record and provide the run number.

XL USAGE LOG ON/OFF

Select ON to log instrument usage; select OFF if you do not want this information saved. Press ENTER after highlighting your selection.

NOTE

Be sure to have this toggle on if you intend to print out a record of instrument usage. If the toggle is off, there won't be any records to print.

RUN RESULTS — AUTO PRINT ON/OFF

Select ON to print run results automatically at the end of each run. Select OFF if you do not want this information printed automatically. Press ENTER after highlighting your selection.

SET DATE

Select **Set Date** and press ENTER to enter or modify the date provided on the printouts. (Leap year is corrected for by the internal calendar circuitry.) The date is shown as year/month/day (yy/mm/dd).

Use the LEFT and RIGHT arrow softkeys to position the cursor on the digit you want to change. Use the keypad to enter the appropriate numbers.

Select ENTER to complete the entry or CE to exit the field without making any changes.

SET TIME

Select **Set Time** and press (ENTER) to enter or modify the time shown on the printouts. The time is shown as hours:minutes (hh:mm), using the 24-hour format.

Use the (LEFT) and (RIGHT) arrow softkeys to position the cursor on the digit to be changed. Use the keypad to enter the appropriate numbers.

Select (ENTER) to complete the entry or (ce) to exit the field without making any changes. When a new time is set, the seconds, which are not visible, are reset to 0.

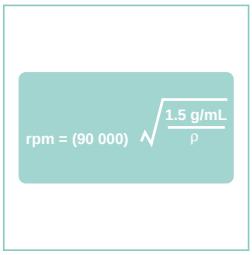
SET XL ID

Select **Set XL ID** and press (ENTER) to enter or modify the instrument identification number (appears at the bottom of the screen between the date and time) to track which instrument generated the printout, when you have more than one Optima XL in your lab.

Use the (LEFT) and (RIGHT) arrow softkeys to position the cursor on the digit you want to change. Use the keypad to enter the appropriate numbers.

Select (ENTER) to complete the entry or (ce) to exit the field without making any changes. When a new ID number has been set, it is used on all subsequent printouts.

6
Calculations



The Calculations feature performs a variety of calculations commonly used in ultracentrifugation. These calculations, which may be used while the instrument is at rest or while a run is in progress, are provided to help simplify your run preparation.

THE CALCULATIONS MENU

Press the (MORE OPTIONS) softkey at the Main Screen to access the (CALC MENU) softkey. Press the (CALC MENU) softkey to display the menu of available calculations (Figure 6-1).

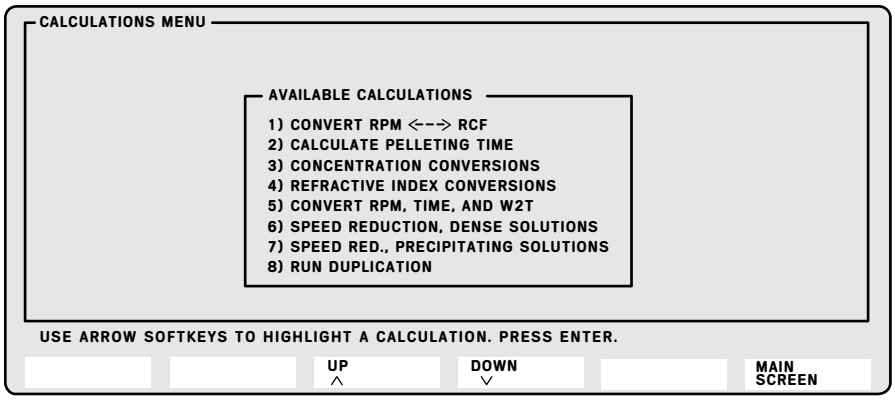


Figure 6-1. The CALCULATIONS MENU Screen

ENTERING INFORMATION

Note the following general points on entering information before proceeding with individual calculations. The prompt lines and softkey labels will change as required to assist you in executing the calculations.

- Use the arrow softkeys or the keypad to highlight the required calculation on the menu. Then press (ENTER) to access the appropriate screen.
- Use the keypad to enter numerical values. (Where appropriate, valid ranges are listed as part of the prompt line.) *Be sure to include the decimal point where appropriate when entering values.* Then press (ENTER). Otherwise you will erase the value when you move to another field.
- Use the (PREVIOUS FIELD) and (NEXT FIELD) softkeys to move the cursor to the previous or next field on the screen. In a few cases, such as when you are accessing a SPEED or TIME field, you may also use the equivalent hardkeys to highlight the field.
- Press the (ROTOR) softkey (or hardkey) to display the ROTOR CATALOG when you need to select a rotor for the calculation. When you have selected a rotor, you will be given a choice of *g*-Max tubes to select for use with that rotor.
- Press (CALC MENU) or (ce) to abort the calculation and return to the CALCULATIONS MENU.
- Press (MAIN SCREEN) or (ce) to leave the CALCULATIONS MENU and return to the Main Screen.

When a lengthy computation is being processed, blinking dashes appear in the appropriate field to indicate that the calculation is in progress.

CONVERSIONS BETWEEN SPEED (RPM) AND RELATIVE CENTRIFUGAL FORCE (RCF)

To select this calculation (Figure 6-2), use the arrow keys to highlight it, then press (ENTER).

USER INPUTS

Enter the applicable inputs, depending on the calculations required.

ROTOR—Press the (ROTOR) softkey (or hardkey) to access the ROTOR CATALOG. Use the arrow softkeys to highlight a rotor. Press (ENTER).

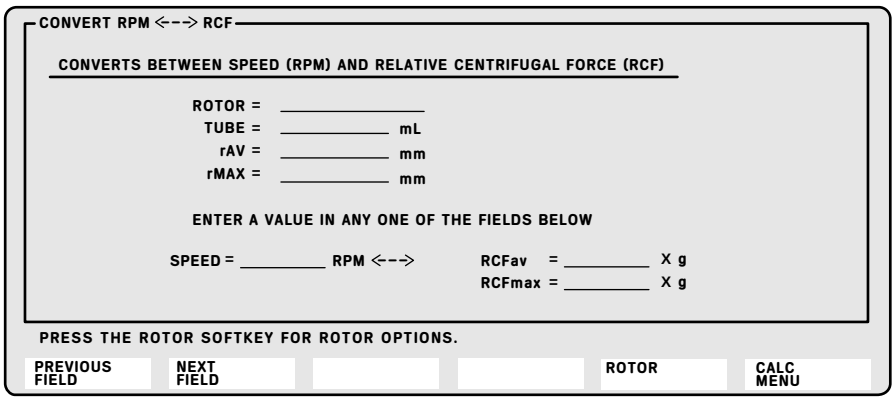


Figure 6-2. Conversions Between Speed and Relative Centrifugal Force

TUBE —Use the arrow softkeys to select a *g*-Max tube for the conversion, then press (ENTER).

rAV—The radial distance (in millimeters), halfway between rMAX and rMIN, is filled in automatically when you select a rotor/tube combination from the catalog. You may enter a different value manually, but doing so will remove the rotor/tube combination previously entered. When you are finished with this field, press (ENTER).

rMAX—The radial distance (in millimeters) from the rotor's axis to the furthermost surface of the tube is filled in automatically when you select a rotor/tube combination from the catalog. You may enter a different value manually, then press (ENTER). If you change rMAX, however, the ROTOR and TUBE fields will be cleared; the calculation may still be performed.

SPEED —Use the keypad to enter the speed in RPM and press (ENTER) to calculate RCF values.

RCFav—The relative centrifugal force at the average radius of the rotor. Use the keypad to enter a value and press (ENTER) to calculate speed and RCFmax.

RCFmax—The relative centrifugal force at the maximum radius of the rotor. Use the keypad to enter a value and press (ENTER) to calculate speed and RCFav.

CALCULATIONS

Depending on the inputs, the instrument calculates the following.

SPEED—Speed is calculated if you entered a value for either RCFav or RCFmax. (Any value below 1000 rpm is shown as 0 rpm.).

RCFav—RCFav is calculated if you entered a value for either RCFmax or speed.

RCFmax—RCFmax is calculated if you entered a value for either RCFav or speed.

CALCULATE PELLETING TIME

To select this calculation (Figure 6-3), use the arrow keys to highlight it, then press ENTER.

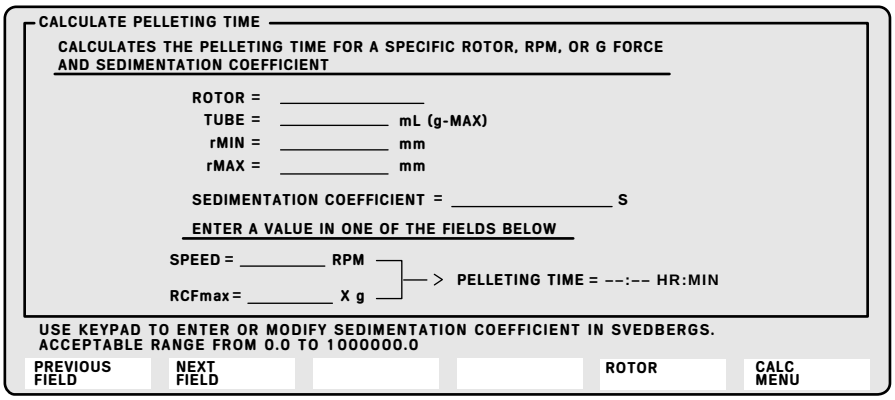


Figure 6-3. Calculating Pelleting Time

USER INPUTS

Enter the applicable inputs, depending on the calculations required.

ROTOR—Press the ROTOR softkey (or hardkey) to access the ROTOR CATALOG. Use the arrow softkeys to highlight a rotor. Press ENTER.

TUBE—Use the arrow softkeys to select a *g*-Max tube for the calculation, then press ENTER.

rMIN—The rotor's minimum radius in millimeters (radius to the top of the tube) is filled in automatically when you select a rotor/ tube combination from the catalog. You may enter a different value manually, then press ENTER. If you change rMIN, however, the ROTOR and TUBE fields will be cleared, but the calculation may still be executed.

rMAX—The radial distance (in millimeters) from the rotor's axis to the furthermost surface of the tube is filled in automatically when you select a rotor from the catalog. You may enter a different value manually, then press ENTER. If you change rMAX, however, the ROTOR and TUBE fields will be cleared, but the calculation may still be executed.

SEDIMENTATION COEFFICIENT—Sedimentation velocity per unit of centrifugal force for the particle of interest. Use the keypad to enter a sedimentation coefficient in Svedberg units (*S*). Press ENTER.

SPEED—Use the keypad to enter the speed in RPM and press ENTER to calculate pelleting time and the RCFmax.

RCFmax—The relative centrifugal force at the maximum radius of the rotor. Use the keypad to enter a value and press ENTER to calculate pelleting time and speed.

CALCULATIONS

Depending on the inputs, the instrument calculates the following.

PELLETING TIME—The time required for pelleting to occur in hours: minutes is calculated when a value for speed or RCFmax is entered. A message indicating that the time is impractical will be displayed if the time is below 0:15 or above 99:59.

SPEED—Speed is calculated if you have entered a value for RCFmax. (Any value below 1000 rpm is shown as 0 rpm.)

RCFmax—RCFmax is calculated if you have entered a value for speed.

CONCENTRATION CONVERSIONS

To select this calculation (Figure 6-4), use the arrow keys to highlight it, then press ENTER. The calculation is based on a temperature of 20°C.

USER INPUTS

Enter the applicable inputs, depending on the calculations required.

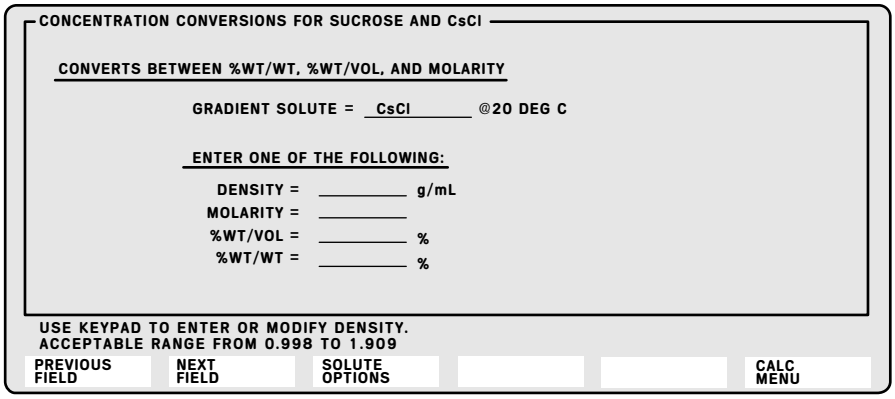


Figure 6-4. Concentration Conversions for Sucrose and CsCl

GRADIENT SOLUTE—CsCl or sucrose. Press the (SOLUTE OPTIONS) softkey and, if necessary, the arrow softkeys to select CsCl or sucrose as the gradient solute. Press (ENTER).

DENSITY—Use the keypad to enter a density in g/mL within the range permitted for the solute, then press (ENTER). (The default value is 0.998 g/mL, the density of pure water at 20°C.)

MOLARITY—Use the keypad to enter a value within the range permitted for the solute, then press (ENTER) to calculate the other parameters.

%WT/VOL—Use the keypad to enter a concentration in %WT/VOL within the range permitted for the solute, then press (ENTER) to calculate the other parameters.

%WT/WT—Use the keypad to enter a concentration in %WT/WT within the range permitted for the solute, then press (ENTER) to calculate the other parameters.

CALCULATIONS

If a value for density, molarity, concentration in %WT/ VOL, *or* concentration in %WT/WT is entered, values for the remaining three parameters are calculated.

REFRACTIVE INDEX CONVERSIONS

To select this calculation (Figure 6-5), use the arrow keys to highlight it, then press ENTER.

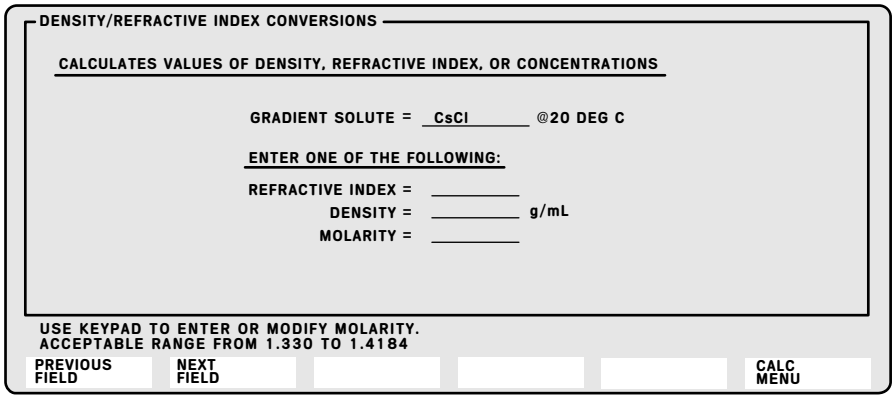


Figure 6-5. Refractive Index Conversions

USER INPUTS

Enter the applicable input, depending on the calculation required.

REFRACTIVE INDEX—Use the keypad to enter a value, then press ENTER. (The default value is 1.3330, the RI of pure water at 20°C.)

DENSITY—Use the keypad to enter a density in g/mL within the range permitted for the solute, then press ENTER. (The default value is 0.998 g/mL, the density of pure water at 20°C.)

MOLARITY—Use the keypad to enter a value within the range permitted for the solute, then press ENTER to calculate the other parameters.

CALCULATIONS

If a value for refractive index, density, *or* molarity is entered, values for the other two parameters are calculated.

CONVERT RPM, TIME, AND W2T

To select this calculation (Figure 6-6), use the arrow keys to highlight it, then press ENTER. ($\omega^2 t$ is represented as W2T on the screen.)

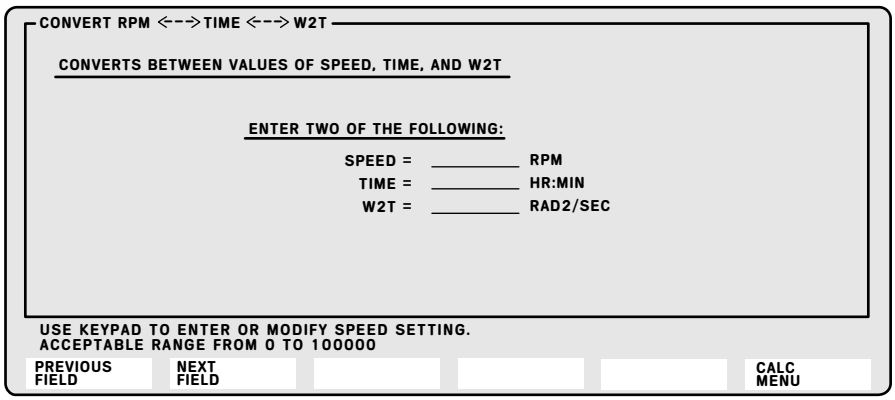


Figure 6-6. Speed, Time, and $\omega^2 t$ Conversions

USER INPUTS

Enter the applicable inputs, depending on the calculations required.

SPEED—Use the keypad to enter the speed in RPM, then press ENTER.

TIME—Use the keypad to enter the time in hours:minutes, then press ENTER.

$\omega^2 t$—Use the keypad to enter a value for $\omega^2 t$ in radians per second, then press ENTER.

CALCULATIONS

Depending on the inputs, the instrument calculates the following.

SPEED—Speed is calculated if you have entered values for time and $\omega^2 t$.

TIME—Time is calculated if you have entered values for speed and $\omega^2 t$.

$\omega^2 t$—$\omega^2 t$ is calculated if you have entered values for speed and time. This calculation is based on the rotor spinning at the designated speed for the full amount of time—changes due to acceleration and deceleration are not included.

SPEED REDUCTION, DENSE SOLUTIONS

The maximum speed permitted for ultracentrifuge rotors must be limited to prevent stress on the rotor as well as to prevent precipitation of gradient materials such as cesium chloride. Where precipitating salts are used, the *lower* of these speed limits should be selected.

This calculation determines the maximum permitted rotor speed for tubes filled with solutions of various average densities. The following calculation determines the maximum speed permitted for full-sized tubes, which avoids precipitation of cesium chloride (fill level is 100 percent).

To select this calculation (Figure 6-7), use the arrow keys to highlight it, then press ENTER.

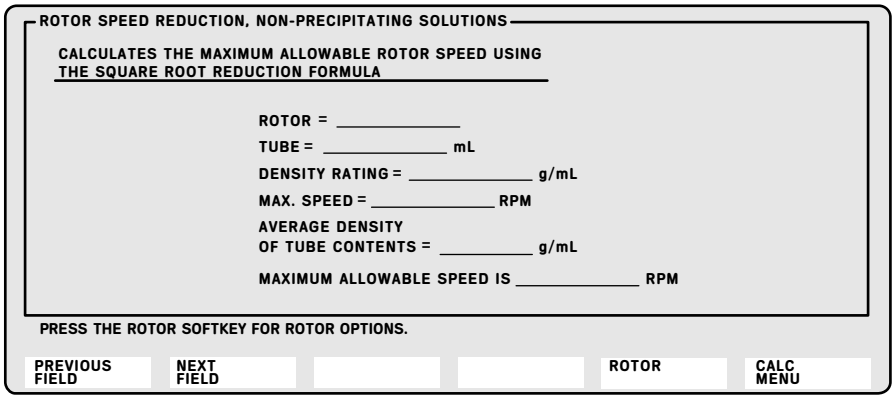


Figure 6-7. Calculating Reduction in Rotor Speed When Using Non-precipitating Solutions

USER INPUTS

Enter the applicable inputs, depending on the known factors.

ROTOR—Press the ROTOR softkey (or hardkey) to access the ROTOR CATALOG. Use the arrow softkeys to highlight a rotor. Press ENTER.

TUBE—Use the arrow softkeys to select a *g*-Max tube for the calculation, then press ENTER.

DENSITY RATING—The maximum density rating is entered automatically when you select a rotor/tube combination from the catalog. You may change this value, but in doing so you will clear the ROTOR/TUBE fields. To change this value, use the keypad, then press ENTER.

MAX SPEED—The maximum speed permitted is entered automatically when you select a rotor/tube combination from the catalog. You may change this value, but in doing so you will clear the ROTOR/TUBE fields. To change this value, use the keypad, then press (ENTER).

AVERAGE DENSITY OF TUBE CONTENTS—Use the keypad to enter a value in g/mL within the acceptable range, then press (ENTER).

CALCULATION

The maximum allowable speed in RPM is calculated as soon as you select a rotor/tube combination (which includes values for density rating and maximum permitted speed) and a value for average density of tube contents.

SPEED REDUCTION, PRECIPITATING SOLUTIONS

To select this calculation (Figure 6-8), use the arrow keys to highlight it, then press (ENTER).

USER INPUTS

Enter the applicable inputs, depending on the known factors.

ROTOR—Press the (ROTOR) softkey (or hardkey) to access the ROTOR CATALOG. Use the arrow softkeys to highlight a rotor. Press (ENTER).

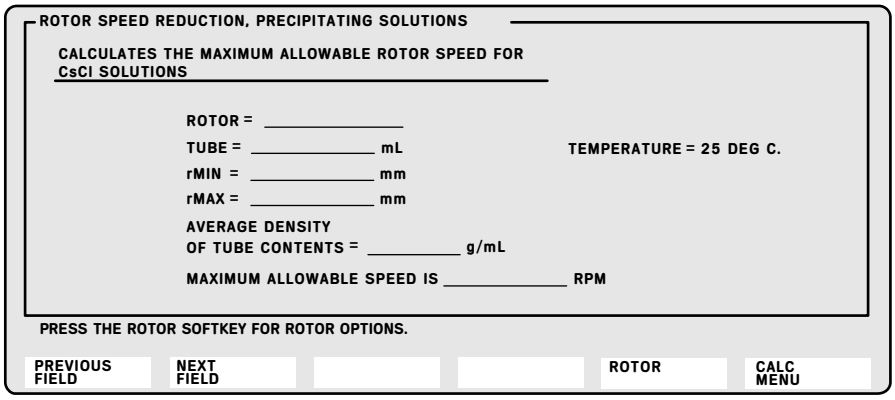


Figure 6-8. Calculating Reduction in Rotor Speed When Using Precipitating Solutions

TUBE—Use the arrow softkeys to select a *g*-Max tube for the calculation, then press ENTER.

MAX SPEED—The maximum speed permitted is entered automatically when you select a rotor/tube combination from the catalog. You may change this value, but in doing so you will clear the ROTOR/TUBE fields. To change this value, use the keypad, then press ENTER.

AVERAGE DENSITY OF TUBE CONTENTS—Use the keypad to enter a value in g/mL within the acceptable range, then press ENTER.

CALCULATION

The maximum allowable speed in RPM is calculated as soon as you select a rotor/tube combination from the catalog (which includes values for density rating and maximum permitted speed) and a value for average density of tube contents. *Note that this calculation is also based on a temperature of 25°C*.

The time it takes to complete this calculation will depend on several variables, including the starting concentration of CsCl and the rotor in use.

RUN DUPLICATION

To select this calculation (Figure 6-9), use the arrow keys to highlight it, then press ENTER.

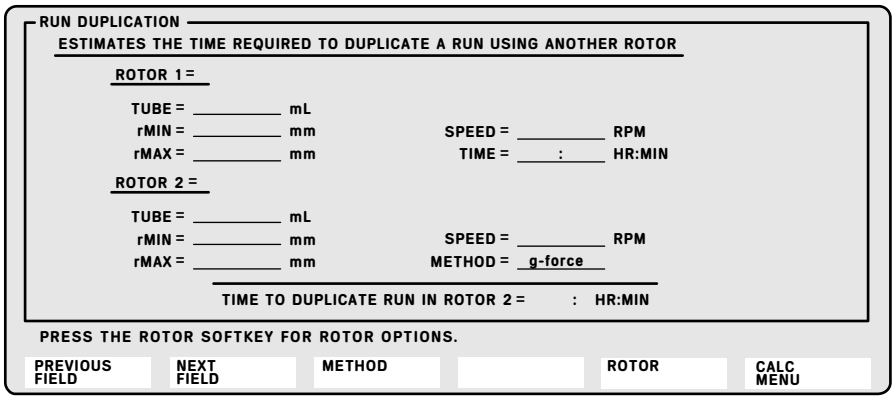


Figure 6-9. Estimating the Time Required to Duplicate a Run

USER INPUTS

After entering the following information for ROTOR 1, enter the inputs for ROTOR 2.

ROTOR—Press the (ROTOR) softkey (or hardkey) to access the ROTOR CATALOG. Use the arrow softkeys to highlight ROTOR 1. Press (ENTER).

TUBE—Use the arrow softkeys to select a *g*-Max tube for this rotor and calculation, then press (ENTER).

rMIN—The rotor's minimum radius in millimeters (radius to the top of the tube) is filled in automatically when you select a rotor/ tube combination from the catalog. If necessary, you may enter a different value manually, then press (ENTER).

rMAX—The radial distance (in millimeters) from the rotor's axis to the furthermost surface of the tube is filled in automatically when you select a rotor/tube combination from the catalog. You may enter a different value manually, then press (ENTER). If you change rMAX, however, the ROTOR/ TUBE fields will be cleared.

SPEED—Use the keypad to enter the speed in RPM within the acceptable range, then press (ENTER).

TIME—Use the keypad to enter the time in hours:minutes. (Not applicable for ROTOR 2.)

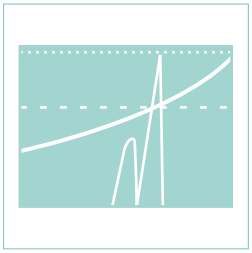
METHOD—Use the (METHOD) softkey and arrow softkeys, if necessary, to select a method of duplication: *k*-factor or *g*-force.

CALCULATION

The time required to perform an equivalent run using ROTOR 2 is calculated in hours:minutes as soon as all the required inputs have been entered. The time required will vary depending on the method you selected.

7

ESP™ Efficient Sedimentation Program



Use of the Efficient Sedimentation Program is described here.

THE EFFICIENT SEDIMENTATION PROGRAM

To provide the shortest possible run times in precipitating media without the risk of damage to the rotor or centrifuge, the Optima XL provides an ESP™ (Efficient Sedimentation Program), which simulates the formation of the gradient and separation of sample components in a selection of Beckman Coulter ultracentrifuge rotor/tube combinations. XL Software Release 2.0 or later supports two types of separations: the isolation of plasmid DNA and the isolation of RNA from cellular lysates.[1]

Run times of absolute minimum duration are provided by operating the centrifuge at speeds which, if continued to equilibrium, would normally result in precipitation of the cesium chloride density gradient material. Given the initial concentration of CsCl in the tube, the simulator predicts the time at which precipitation would occur and automatically decelerates the rotor to the speed required to avoid it. The simulator can also predict the time at which the required separation will be achieved, and may be used to automatically terminate the run when that time is reached.

For plasmid isolations, ESP simulates the separation of any supercoiled DNA molecule in the range 2.5 to 18.7 kbp from its nicked or linear homologue. The separation medium is CsCl at 25°C, at an initial concentration of 4.42 M (density 1.55 g/mL), containing ethidium bromide at 10 mg/mL. A uniform initial distribution of all sample and gradient components is assumed.

Two protocols are provided for the pelleting of RNA molecules in the range 0.1 to 3 kbp or larger, through a cushion of 5.7 M CsCl at 25°C. Both protocols require the use of a swinging bucket rotor. The “fast” protocol is

[1] For cases that assume the presence of either 2 or 10 kbp DNA fragments (depending on the protocol), a minimum RNA size of 1000 bases affords the cleanest separation. Separations using smaller sized RNA may contain co-pelleted DNA.

optimized for speed of separation. The sample is suspended in buffer containing 4 M GuSCN without CsCl, and is layered over a CsCl cushion occupying one-fourth the volume of the tube. To prevent large DNA from pelleting along with the RNA in this separation, the cell or tissue lysate must be sheared to provide DNA fragments smaller than 2 kbp.

The “best” protocol is optimized for purity. It will tolerate initial DNA fragment sizes as large as 10 kbp, thus requiring much less initial shearing of the lysate. In this case, the sample is suspended in 2.95 M CsCl containing 4 M GuSCN and is layered over a CsCl cushion occupying one-third of the tube volume.

THE SOFTKEYS

Note the following general points in operating the ESP softkeys. The prompt lines and softkey labels change as required to assist you in using the ESP software features.

- Press the (MORE OPTIONS) softkey to display the (ESP SCREEN) softkey.
- Press the (ESP SCREEN) softkey to access the EFFICIENT SEDIMENTATION PROGRAM and PROTOCOLS screen (Figure 7-1).
- Press (SAVE AND EXIT), then use the arrow softkeys to confirm either option (save or exit), followed by (ENTER) to return to the ESP PROTOCOLS screen.
- Press the (MAIN SCREEN) softkey to leave the ESP PROTOCOLS screen and return to the Main Screen.

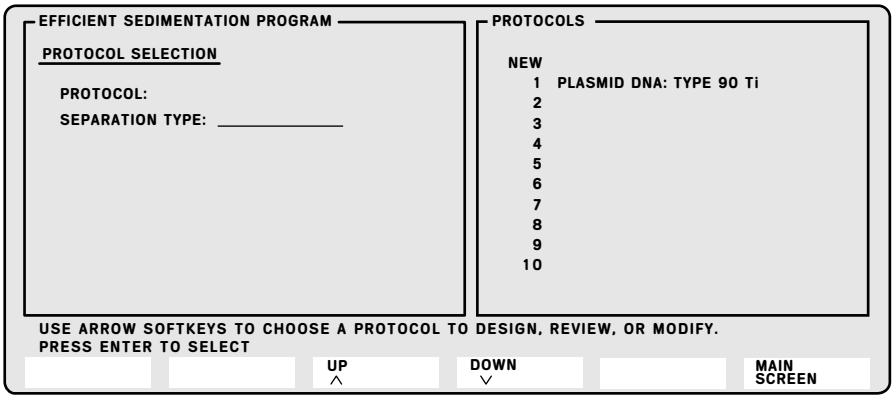


Figure 7-1. The ESP and PROTOCOLS Screen

ENTERING INFORMATION

- Use the arrow softkeys to highlight the menu item and press (ENTER). Or use the keypad to enter numeric values, when necessary, and press (ENTER). In either case, pressing (ENTER) moves you to the next field needing input.
- Use the (PREVIOUS FIELD) softkey to move the cursor to the previous or next field on the screen.
- Press the (ROTOR) softkey (or hardkey) to display the ROTOR CATALOG when you need to select a rotor.

THE ESP PROTOCOL SELECTION SCREEN

1. From the Main Screen, press the (MORE OPTIONS) softkey to access the (ESP SCREEN) softkey.
2. Press (ESP SCREEN); the ESP Protocol Selection screen will appear along with the protocol menu window.
3. Using the (UP /\) and (DOWN \/) softkeys, select a specific protocol or select New from the protocol menu choices on the right-hand side of the Protocol Selection screen. Press (ENTER) when you have finished your selection.
4. Select either a DNA or RNA separation type, if necessary (see Figure 7-2). Press (ENTER) when finished.

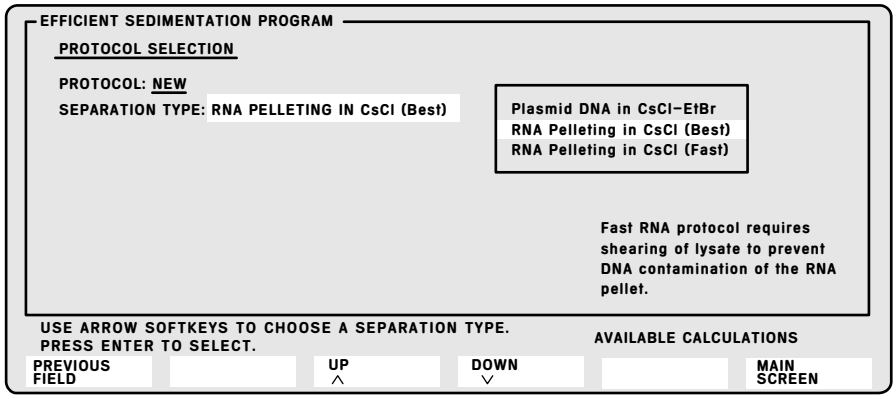


Figure 7-2. Separation Type Selection Screen

THE ESP PROTOCOL DEFINITION SCREEN

1. You may enter a default value (cursor in Figure 7-3 is on the screen update field) for the size of the DNA or RNA by pressing ENTER, or you may enter another value into the highlighted component size field by using the numeric keypad. Press ENTER when finished.

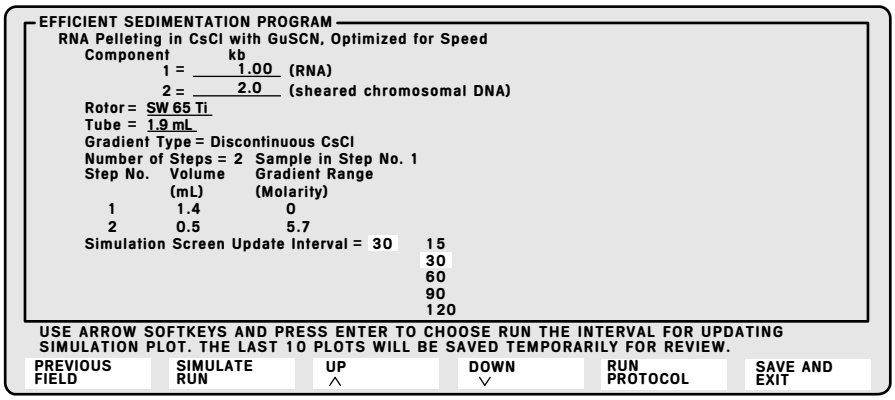


Figure 7-3. ESP Protocol Definition Screen

2. The ROTOR CATALOG window (Figure 7-4) appears displaying the rotors available for the simulation in a menu at the right side of the screen. Use the UP /\ and DOWN \/ and RIGHT arrow softkeys to select a rotor. Press ENTER when finished.

3. The G-MAX TUBES menu[2] (Figure 7-5) appears at the right hand side of the screen. Use the UP /\ and DOWN \/ softkeys to select the *g*-Max tube to be used for the simulation. Press ENTER when finished.

4. Use the UP /\ and DOWN \/ softkeys to select the screen update frequency for the simulation plot. Press ENTER when finished.

5. When all separation parameters are entered into the Definition Screen (Figure 7-3), start the simulation by pressing the SIMULATE RUN softkey.

You may save (or discard) the separation protocol at any time.

[2] To select an OptiSeal tube where appropriate, select the dimensionally equivalent Quick-Seal tube on the menu. In the actual run, however, use the OptiSeal tube.

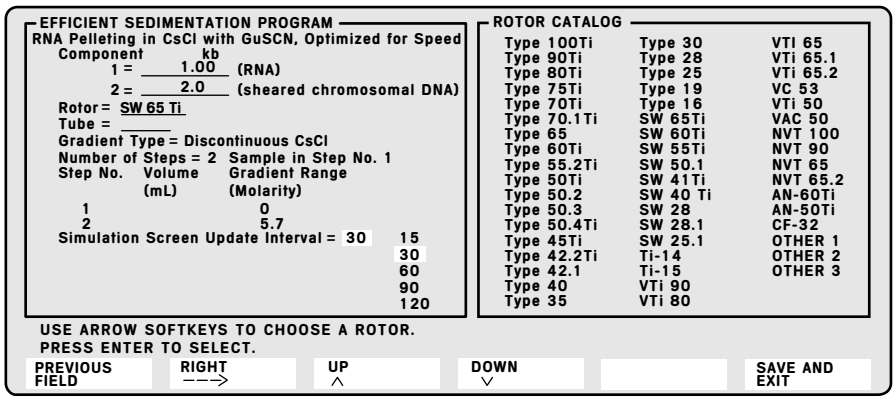


Figure 7-4. ROTOR CATALOG Window

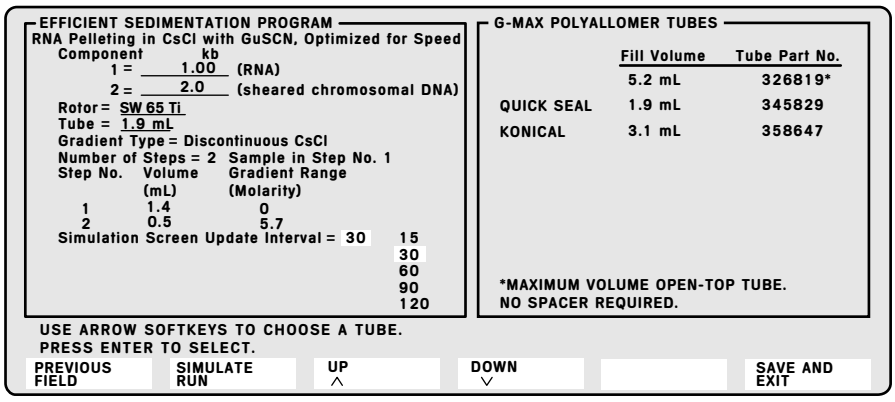


Figure 7-5. G-MAX TUBES Menu

6. To save or exit the Protocol Definition screen, press the (SAVE AND EXIT) softkey. To enter the protocol into the ESP Protocol menu and database, or to discard the protocol and begin again, use the arrow softkeys to select either SAVE or DON'T SAVE and press (ENTER) to confirm your choice.

   - If you selected SAVE, use the arrow softkeys or the keypad to assign a number to the new protocol, which will be added to the Protocol menu, and will return you to the Protocol Selection screen.

   - If you selected DON'T SAVE, you will exit the Protocol Definition screen without saving the defined protocol and will be returned to the Protocol Selection screen.

SIMULATE THE RUN

Press SIMULATE RUN to display a graphic representation of the run (see Figure 7-6). The simulation is represented by a number of graphical data sets. A message on the screen indicates which data set is being calculated. As each data set is shown, the values at the left are updated.

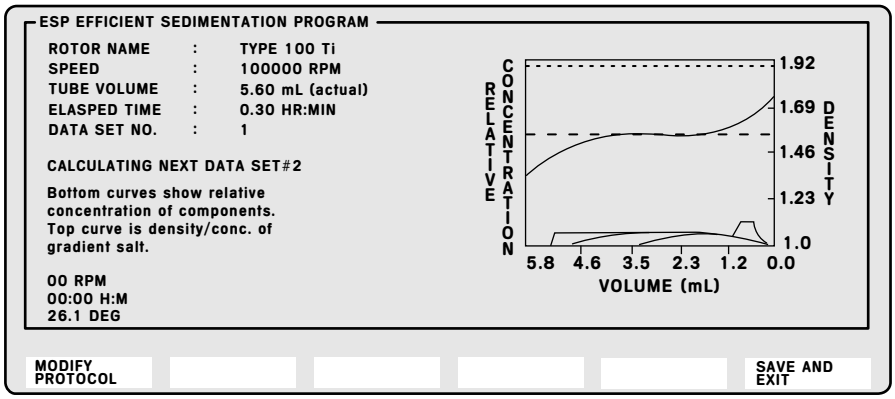


Figure 7-6. Graphic Representation of the Simulation—Data Set 1

- The top curve represents the density of the gradient.
- The bottom curves indicate the relative concentration of the sample components.
- The dotted line at the very top of the graph represents the concentration at which CsCl will precipitate.
- The dotted line near the middle of the graph represents the initial density (1.55 g/mL) of the gradient.

To abort the simulation, press MODIFY PROTOCOL or press SAVE AND EXIT to return to the ESP Main Screen.

When the simulation is complete, the final graphics remain on the screen as shown in Figure 7-7; PREVIOUS PLOT and NEXT PLOT softkeys appear so that you can move back and forth from one data set to another—you may review the graph and values for the last 10 data sets.

Press MODIFY PROTOCOL to return to the ESP Protocol Definitions screen, or press SAVE AND EXIT to return to the ESP main screen.

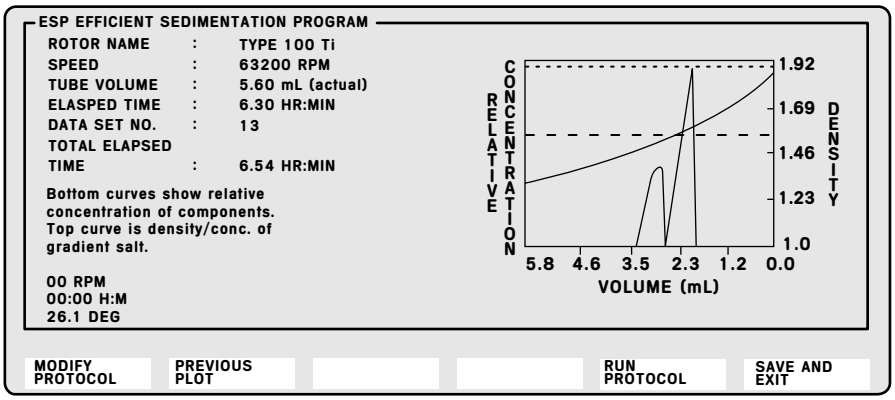


Figure 7-7. Graphic Representation of the Simulation—Data Set 10

RUN ESP PROTOCOL

Press the (RUN PROTOCOL) softkey while at the ESP Protocol Definition screen or the ESP Simulation screen to select the ESP settings for your run. The ESP settings will be generated by the ESP simulation, and the (RUN PROTOCOL) softkey will be available when the simulation is complete.

NOTE

If program settings have already been loaded, a message will appear asking you to return to the Main Screen to clear them before continuing. To do so, press (MAIN SCREEN) and (ce). Then press (ESP SCREEN) and (RUN PROTOCOL) again.

You will be returned to the Main Screen (Figure 7-8). The initial ESP settings will be displayed on the right, the title bar indicating that this is an ESP programmed run. The softkey remains displayed for access to the ESP option.

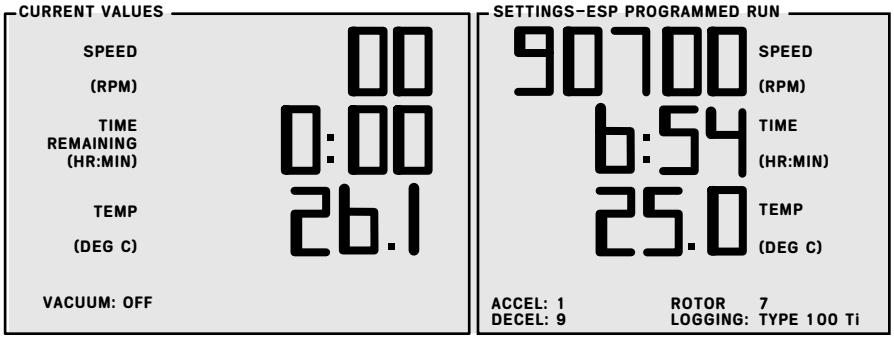


Figure 7-8. Using the ESP Settings

Once selected, the ESP settings usually cannot be changed. However, after the ESP run settings are entered and you return to the Main Screen, you can select a DECEL profile for the last step of the run as follows.

1. Press the (DECEL PROFILES) softkey.

2. Enter a profile number and press (ENTER). The selected profile will appear in the lower left corner of the SETTINGS window. The DECEL profile will be used during the *last* step of the ESP run.

The run terminates automatically at the completion of the final step unless you press (STOP) beforehand. (See Section 3 for general information on multi-step programs.)

The ESP settings cannot be loaded for use if a run is already in progress.

If (STOP) is pressed during an ESP or sequential run, the run will be terminated. To resume and finish the run, press the (ENTER) and (START) hardkeys before the rotor comes to rest. The run will then resume from the beginning of the **step that was in progress** when the (STOP) hardkey was pressed, regardless of the time elapsed in that step before the run was terminated.

NOTE

If the run is interrupted by a loss of power, the run will automatically resume and finish (as if there was no power interruption) when the power is restored.

8

Summary of Run Procedures

WARNING

Do not use the Optima XL 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 Optima XL is designed for normal, locked, and zonal operation. Use any Beckman Coulter rotor and consult the applicable rotor manual for detailed information on preparing the rotor for centrifugation. Each rotor manual includes rotor specifications, information on loading/unloading and balancing procedures, precautions to ensure chemical and biological safety during centrifugation, and instructions regarding care of the rotor and accessories. Refer also to Rotors and Tubes *for additional information on the use and care of rotors, tubes, and accessories.*

KEY IN THE NORMAL POSITION

STANDARD OPERATION

1. Turn the key to the right (clockwise) to the normal position.
2. Enter the run settings—SPEED, TEMP, and TIME, HOLD, or $\omega^2 t$—following the prompts on the screen.
3. Select slow ACCEL and DECEL profiles, if necessary. If profiles are not selected, the instrument automatically uses the default values—the rotor will accelerate and decelerate at maximum rates.
4. If required, identify the rotor for logging. Press (ROTOR), use the keypad to enter the rotor line number, then press (ENTER).
5. Press (ENTER) and (START). (If you did not already press (VACUUM), the system is automatically activated now.)

Press (STOP) to terminate a run in the HOLD mode. Runs in the TIME and $\omega^2 t$ modes will terminate automatically. After the rotor has stopped, press (VACUUM) to vent the chamber.

Open the chamber door and remove the rotor as described in the rotor manual. Keep the door closed between runs to help keep the chamber clean and dry.

REPEATING THE SAME RUN

To repeat this run, just press (ENTER) and (START). There is no need to re-enter the run conditions unless you want to make a change. You will need to re-enter the rotor for logging, however, since this field is cleared at the end of a run.

PROGRAMMED OPERATION

1. Press the (PROGRAM LIBRARY) softkey.
2. Use the keypad to select the program by number and press (ENTER). The selected program settings will be displayed in the SETTINGS window. (If you selected the sequential program, settings for Step A will be displayed.)
3. If required, identify the rotor for logging. Press (ROTOR). Use the keypad to enter the rotor line number, then press (ENTER).
4. Press (ENTER) and (START) to begin the run.

Press (STOP) to terminate a run in the HOLD mode. Runs in the TIME and $\omega^2 t$ modes will terminate automatically. After the rotor has stopped, press (VACUUM) to vent the chamber.

If (STOP) is pressed during an ESP or sequential run, the run will be terminated. To resume and finish the run, press the (ENTER) and (START) hardkeys before the rotor comes to rest. The run will then resume from the beginning of the step that was in progress when the (STOP) hardkey was pressed, regardless of the time elapsed in that step before the run was terminated.

Open the chamber door and remove the rotor as described in the rotor manual. Keep the door closed between runs to help keep the chamber clean and dry.

If the run is interrupted by a loss of power, the run will automatically resume and finish when the power is restored (if the rotor is spinning above 1000 rpm; see Section 9 for more details).

KEY IN THE LOCKED POSITION

To ensure that run conditions are not changed during centrifugation, use the locked operation as follows.

1. With the key in the normal (clockwise) position, enter the run conditions as described for standard and programmed runs.

2. Press (ENTER) and (START) to begin the run. Then turn the key to the vertical, (locked) position and remove the key.

The run status message LOCKED will be displayed in the lower right corner of the CURRENT VALUES window to indicate that the instrument is in a locked operation.

(ENTER), (START), and (VACUUM) remain functional during the locked operation. Other run conditions cannot be changed, however, until the key is reinserted and returned to the normal position.

KEY IN THE ZONAL POSITION

WARNING

In zonal operation, the operator is unavoidably exposed to rotating machinery. For safety, the operator must be properly instructed and qualified. Guard against accidentally dropping objects into the chamber. Loose lab coats, neckties, scarves, and long necklaces should not be worn while operating in the zonal mode.

Do not use a non-zonal rotor in the zonal mode.

1. Precool the zonal rotor to the required temperature.

2. Turn the key to the left (counterclockwise) to the zonal position. This permits open-door operation up to 3000 rpm. The run status message ZONAL will be displayed in the lower right corner of the CURRENT VALUES window.

3. Prepare the rotor assembly. Install the rotor, anticondensation shield, and rotating seal assembly according to the instructions in the zonal rotor instruction manual.

4. Enter the run settings—SPEED, TEMP, and TIME, HOLD, or $\omega^2 t$—following the prompts on the screen. (In the TIME and $\omega^2 t$ modes, the instrument will not begin counting time remaining until the chamber door is closed after the rotor has been loaded, the vacuum level drops below 750 microns, and the rotor speed reaches 3100 rpm.)

5. Press (ENTER) and (START). The ZONAL SETUP message appears in the CURRENT VALUES window, indicating that the rotor is accelerating to loading speed (either the default loading speed of 2000 rpm or a user-specified speed from 2000 to 3000 rpm). The rotor remains spinning at the loading speed until you close the chamber door.

NOTE

If you are performing consecutive zonal runs: at the end of each zonal run, the centrifuge will automatically reset to the normal mode. To reconfirm selection of the zonal mode, you must turn the key left to right (clockwise) from the zonal position to the normal position and then back to the zonal position. Then press (ENTER) and (START) again to begin the run. If you press (ENTER) and (START) without having reset the key, the DOOR OPEN diagnostic message will be displayed in the CURRENT VALUES window, and the instrument will not start. Press (CE) to clear the diagnostic; to begin operation, turn the key as described above and press (ENTER) and (START) again.

6. Load the rotor.

7. Disconnect the seal assembly and cap the rotor.

8. Close the chamber door. The vacuum system will activate automatically. The rotor will hold at 3000 rpm (while displaying the message WAIT FOR VAC) until the chamber pressure drops below 750 microns, at which time it will accelerate to set speed and the instrument will begin counting time remaining or time elapsed.

9. When the run is ended (time remaining at zero, $\omega^2 t$ value reached, or (STOP) pressed), the rotor decelerates to 2000 rpm.

NOTE

To abort a zonal run in progress, press (STOP). When the rotor speed decelerates to 2000 rpm, press (STOP) again.

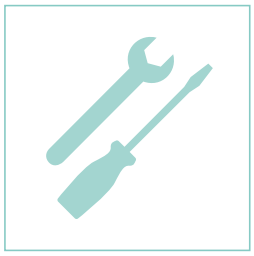
10. When the SPEED setting indicates that the rotor is spinning at 2000 rpm, a series of beeps will sound; press (VACUUM) to vent the chamber. Then open the chamber door.

11. Unload the rotor according to the instructions in the zonal rotor manual. Press (STOP) after unloading to bring the rotor to rest. Keep the door closed between runs to help keep the chamber clean and dry.

NOTE

When the rotor is at rest, the instrument will automatically reset to the normal mode and the ZONAL message will disappear.

9



Troubleshooting and Maintenance

This section contains troubleshooting and maintenance procedures that should be performed regularly. Troubleshooting and maintenance not covered in this manual should be handled by your Beckman Coulter Field Service representative. Refer to the applicable rotor manual and Chemical Resistances *(publication IN-175) for instructions on the care of rotors and their accessories.*

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 representatives.

IN CASE OF POWER FAILURE DURING THE RUN

If a power failure occurs during a run, the rotor begins to decelerate with the brake off. If the rotor is still spinning above 1000 rpm when power is restored, the Optima XL will resume standard or programmed operation and the rotor will return to set speed. A diagnostic message will alert you that a power outage occurred.

If the rotor is spinning below 1000 rpm when power is restored,

- In TIME mode, the timer resets to the original time setting and starts counting down.
- In HOLD mode, the timer resets to zero and starts counting up.
- In $\omega^2 t$ mode, the timer resets the $\omega^2 t$ to zero and starts counting up.
- In ESP or multi-step mode, the system repeats the step during which the power failure occurred, from the beginning of that step. This includes delayed start steps, which are specified by setting 0 rpm and a specific amount of time for Step A of a program.

RETRIEVING YOUR SAMPLE

WARNING

Any maintenance procedure requiring removal of a panel exposes the operator to the possibility of electrical shock and/or physical 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 performed 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 front panel to disengage the door lock.

1. Remove the key from the key switch and tear off any paper extending from the printer before trying to slide the control head cover off the instrument.

2. Locate the two metal latches (see Figure 9-1) 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.

3. To remove the front panel, use a long, thin tool (about 1.5 mm in diameter) to depress the latch (see Figure 9-2). 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 towards you.

4. Lift the front panel to free the bottom tabs that secure it in place.

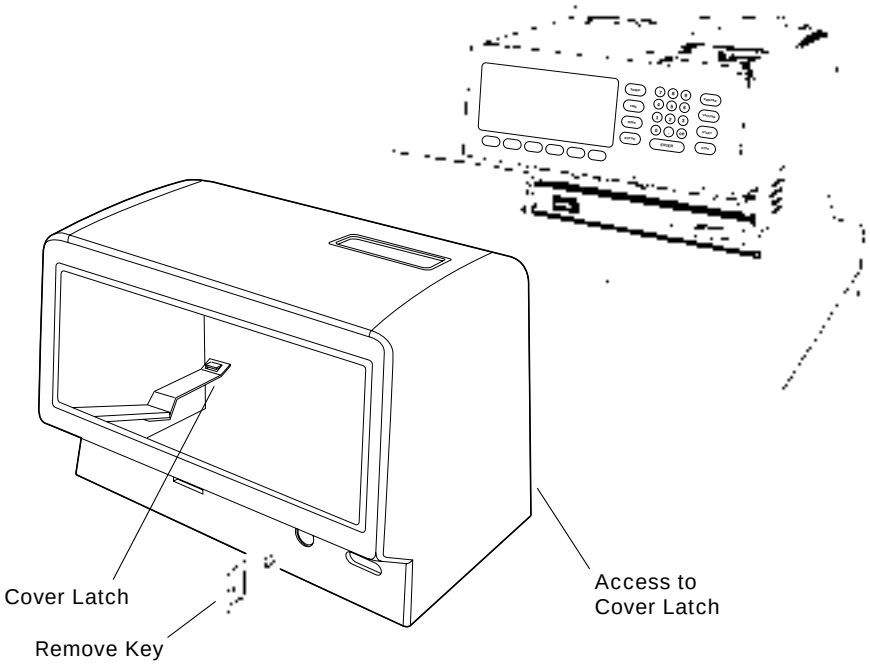


Figure 9-1. Removing the Control Head Cover

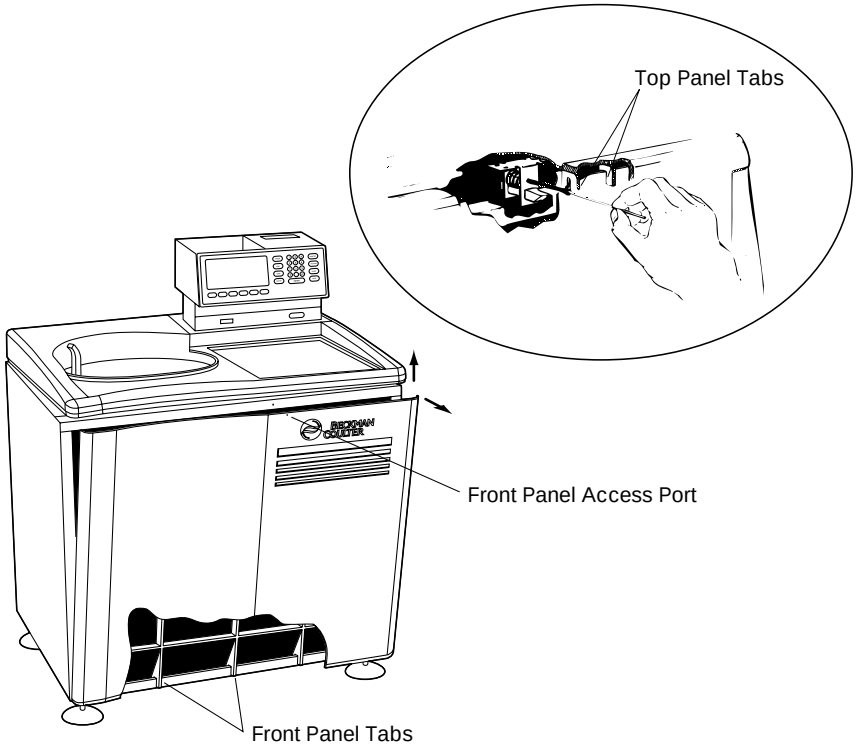


Figure 9-2. Depressing the Latch to Loosen the Front Panel

WARNING

After removing the panel, listen carefully for any sounds coming from the drive. Then touch the fan housing (see Figure 9-3) to feel if it is vibrating and listen again. Do not proceed if any sound or vibration is emitted from the housing.

5. Vent the vacuum chamber by slowly turning the small setscrew on the vacuum solenoid valve to the right (clockwise) as shown in Figure 9-3 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.

6. About 10 seconds after the hissing noise stops, turn the setscrew to the left (counterclockwise) until it stops.

7. Push down on the interlock pin with your finger (Figure 9-3) 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.

WARNING

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

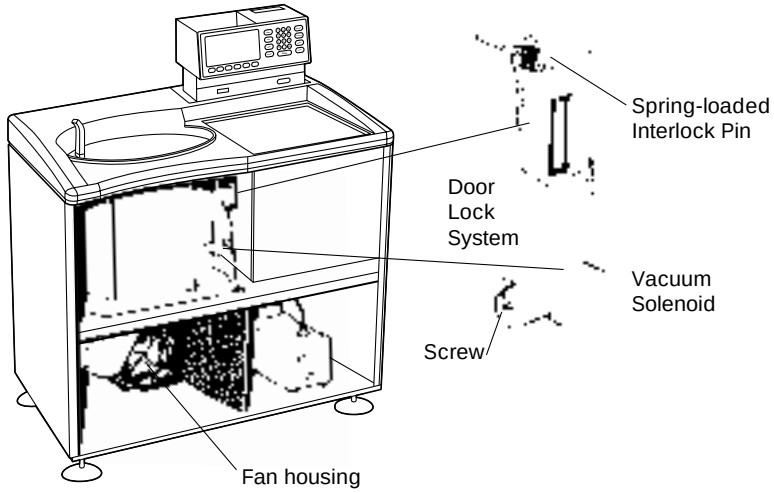


Figure 9-3. Interior View of Instrument (Panel Removed)

8. After retrieving the sample, close the chamber door, then replace the front panel on the instrument. Insert the tabs at the bottom of the panel onto the lip at the base of the instrument, being sure to align the front panel with the side panels. (See Figure 9-4)

9. 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.

10. Replace the control head by sliding it along the small ridges provided, making sure to clear the printer on top and the emergency power 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.

11. Return the key to the interlock switch.

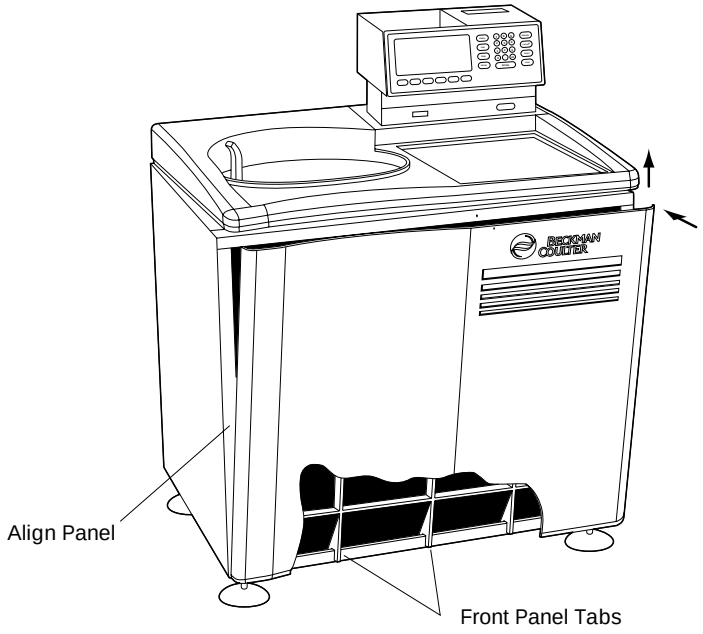


Figure 9-4. Reinstalling the Front Panel

ERROR MESSAGES

If you make an error that interferes with the instrument's operation, an error message will appear below the CURRENT VALUES window and a tone will sound. Follow the prompt to correct the error and then proceed.

DIAGNOSTIC MESSAGES

If an abnormal condition arises, a diagnostic message will be displayed below the CURRENT VALUES window in reverse video (see Figure 9-5) to indicate the problem and an appropriate course of action. A tone also sounds to alert you to the condition. If more than one problem exists, the most critical one will be identified on the screen. Press ce to clear the diagnostic message after correcting the problem. (The message will reappear if the problem still exists.)

Sometimes the message provides cautionary information and the run continues uninterrupted. For example, if the SPEED setting is higher than the speed permitted by the rotor overspeed disk, the speed will be lowered to the maximum speed permitted and a diagnostic message will indicate that this change has been made.

If a serious problem arises, the instrument will shut down with or without the brake (or without temperature control), depending on the specific problem. If necessary, the instrument will automatically trip the power. You will be prompted to take corrective action or, if there is no operator solution, call your Beckman Coulter Field Service representative.

Each diagnostic category has a range of numbers (and letters if necessary) to assist Field Service in determining the nature of the problem. For example, speed-related problems use a diagnostic range beginning with 3 (see the Troubleshooting Chart). *Be sure to indicate the diagnostic number that has appeared on the screen* when you contact your Field Service representative for assistance.

Table 9-1 lists the diagnostic category, possible cause of the condition, and appropriate user action. If there is no user action or you cannot correct the problem, call your Field Service representative.

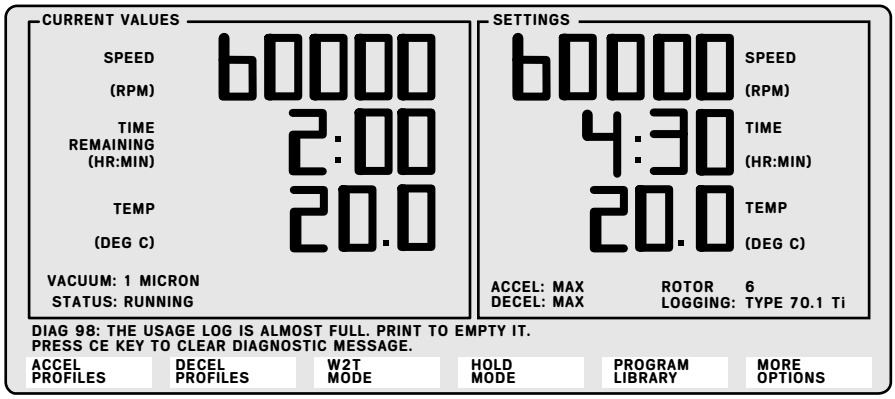


Figure 9-5. Screen with a Diagnostic Message Displayed

Table 9-1. Diagnostic Troubleshooting Chart

Diagnostic Category/Range	Possible Cause	User Action
SPEED 3X	Speed has been set above maximum allowed; or wrong, damaged, or missing overspeed disk	Check set speed; check for clean, undamaged, and correct overspeed disk (see *Rotors and Tubes* for replacement instructions).
TEMPERATURE 5x	Temperature control or vacuum system malfunctioning	Check the air inlet (at bottom of the front panel) for obstructions. Call Beckman Coulter Field Service.
DRIVE 6x	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.
VACUUM 4x	Vacuum not being drawn properly	Check door O-ring for damage and cleanliness; check for excessive moisture—turn the vacuum on for a few hours or overnight; check rotor lid O-rings and possible tube leakage.
IMBALANCE 7X	Rotor imbalance (at low speeds)	Check for proper rotor loading.
DOOR 8x	Door is open when the (START) key is pressed.	Be sure door is closed.
POWER 2x	Loss of power during run	Check TIME display: Run may need to be restarted or aborted.
CPU 1x or 9x	Microprocessor malfunction or loss of program memory	No user action. Call Beckman Coulter Field service.
If trouble persists, call Beckman Coulter Field Service. (1-800-551-1150 in the United States; worldwide offices are listed at the back of this manual).		

CLEANING

Clean instrument surfaces using a cloth dampened with a mild detergent solution such as Beckman Solution 555™ (339555). Be careful not to spill liquid into 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.)

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.

CONTROL PANEL, MESH FILTER, AND DISPLAY SCREEN

Use only a mild detergent solution such as Solution 555 to clean the control panel, since it is finished with coated polycarbonate.

To clean the mesh filter, remove it by gently pulling the top edge of the bezel towards you to free the filter. Use a soft brush or lint-free cloth to remove lint and dust. Wipe off the display screen with a damp, lint-free cloth. Reinstall the mesh filter by seating the bottom edge of the bezel in place, then pressing the top edge towards the screen until it snaps into place.

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

To ensure that the instrument does not get damaged, 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.

ADJUSTING THE DISPLAY SCREEN BRIGHTNESS

When your instrument is installed, your Beckman Coulter Field Service representative will check the brightness of the screen and adjust it if necessary. To adjust it at a later time, locate the small screw at the back of the control head (see Figure 9-6). Use a small nonconductive screwdriver to turn the screw to the left or right to adjust the contrast.

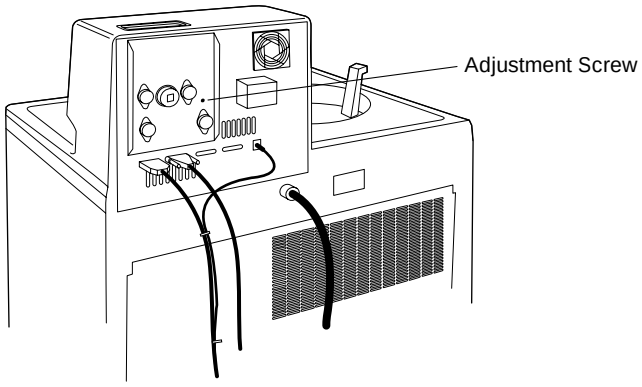


Figure 9-6. Location of the Screw that Adjusts Video Brightness

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

PRINTER MAINTENANCE

To change the ribbon (927506) or replace the paper (927505), you must remove the control head cover to gain access to the printer. Follow the instructions provided under **Retrieving Your Sample** earlier in this section. Once the control head cover is removed, locate and review the summary of instructions fastened to the inside of the cover.

CHANGING THE PRINTER PAPER

1. Pull the latch to the left.
2. Lift the printer assembly up and tilt it towards you. Release the latch so that it holds the printer in the raised position (see Figure 9-7).

WARNING

Be careful NOT to touch the print head immediately after printing as it can get very hot.

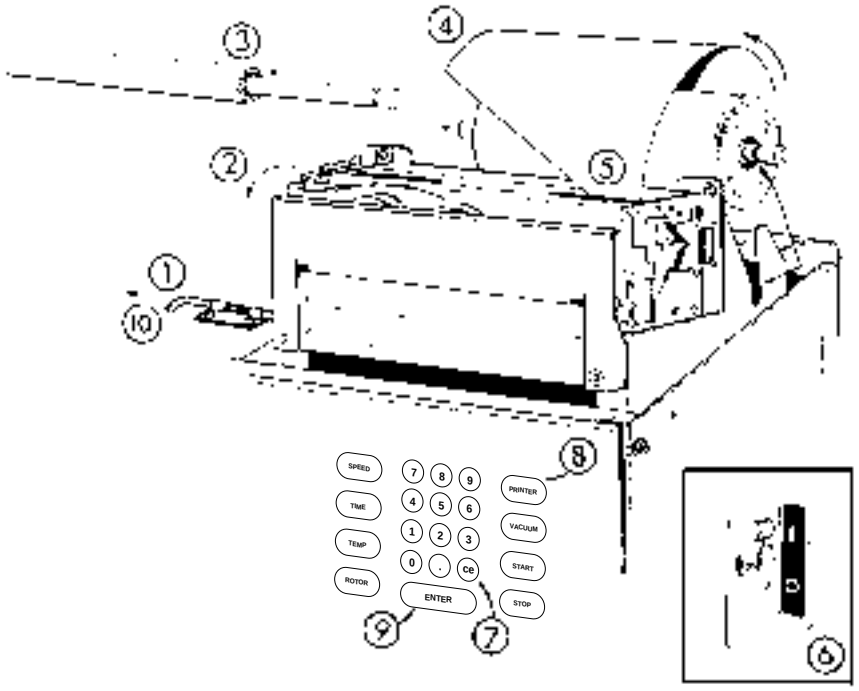


Figure 9-7. Printer Assembly in Raised Position

3. Lift the grooved rod from the slots to remove the old paper roll. Discard the old paper roll but keep the rod.

4. Trim the edge of the new paper at an angle, with the pointed edge on the right. Insert the rod through the new roll of paper, then return the rod and paper to the printer, in the slots provided, making sure that the paper feeds from the bottom. Make sure that the grooves in the rod are properly fitted into the slots.

5. Insert the edge of the paper into the printer until it touches the feeder roller—you will not be able to insert it any further. Check that the longer edge of the paper is on the right side (as you face the printer) in order to trip the paper sensor switch.

6. Turn the instrument power off for 2 seconds, then on again to cycle the power to trip the paper sensor switch.

7. Press (ce) to clear the diagnostic message.

8. Press the (PRINTER) hardkey to access the printer menu.

9. Select ADVANCE PAPER, then press (ENTER) several times until the paper feeds through the printer and comes out the slot provided.

10. Pull the latch to the left, lower the printer back into place, then release the latch. Tear off any paper extending from the printer, then replace the control head cover. Press (ENTER) to advance the paper through the slot in the control head cover.

CHANGING THE PRINTER RIBBON

To change the ribbon, you must remove the control head cover to gain access to the printer. Follow the instructions provided under **Retrieving Your Sample** earlier in this section. When the control head cover is removed, follow the instructions below.

WARNING

Be careful NOT to touch the print head immediately after printing as it can get very hot.

1. Remove the paper guide, clear plastic cutter, and two screws as a unit as shown in Figure 9-8.

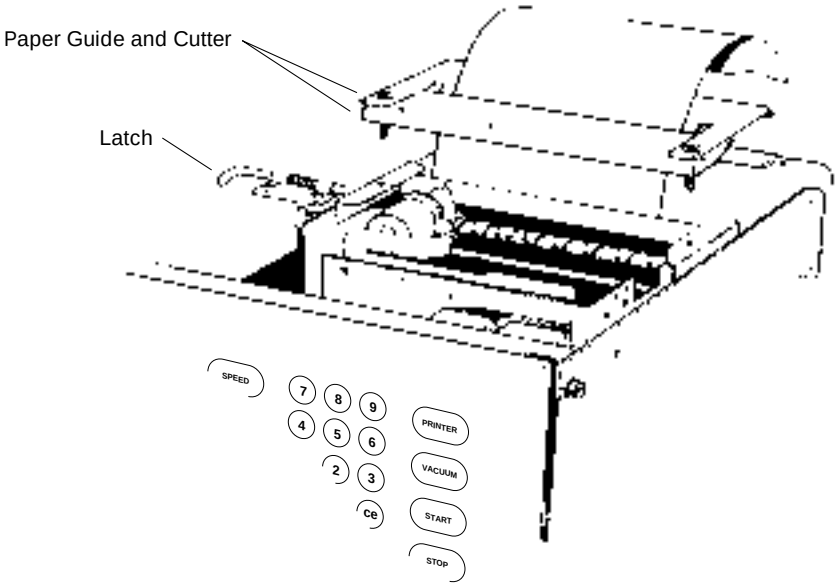


Figure 9-8. Removing the Paper Guide and Plastic Cutter

2. Pull the latch to the left, lift the printer assembly up, and tilt it toward you. Release the latch so that it holds the printer in the raised position.

3. Release the lever that contacts the ribbon and lift one spool off the shaft. Remove the other spool in the same manner, then gently unthread the ribbon from between the platen and print head.

4. To insert a new ribbon, make sure that the empty spool is on the left and that the ribbon travels to the right (clockwise; see Figure 9-9). Be sure that the driving pins on the spools are facing down.

5. Holding the ribbon taut, slide the ribbon between the print head and the platen, wrap it around the black ribbon guide at the right end of the platen, then drop the spool onto the spool shaft. (You will need to release the lever to engage the spool.) You should hear a click as the spool falls into position.

6. Install the other spool in the same fashion. If necessary, turn the left spool to the right (clockwise) to take up the ribbon slack (see Figure 9-10).

7. Release the latch and return the printer assembly to its operating position.

8. Replace the clear plastic cutter and paper guide and tighten the two screws.

9. Reinstall the control head cover as instructed under **Retrieving Your Sample.**

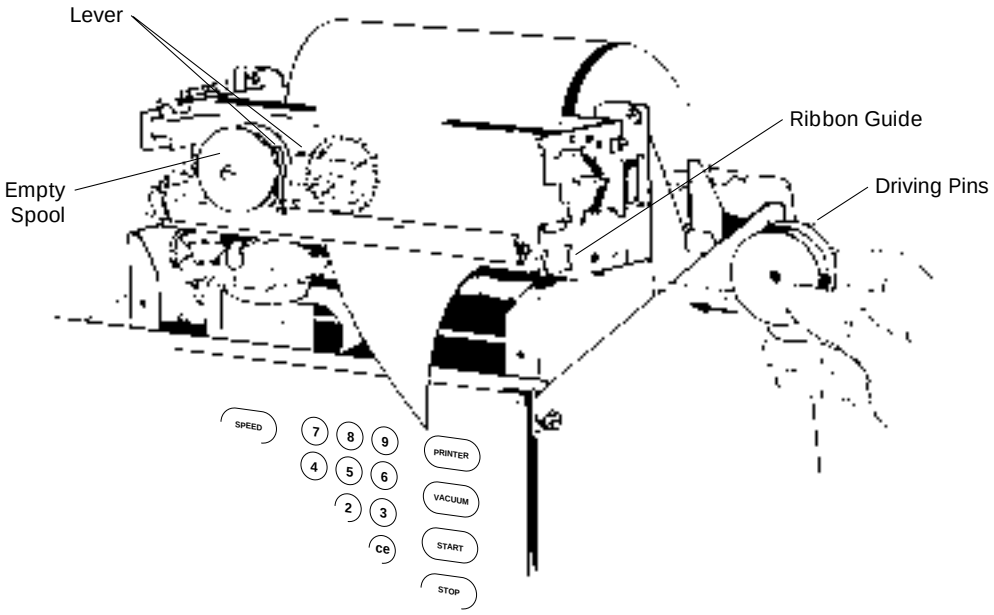


Figure 9-9. Inserting the New Ribbon

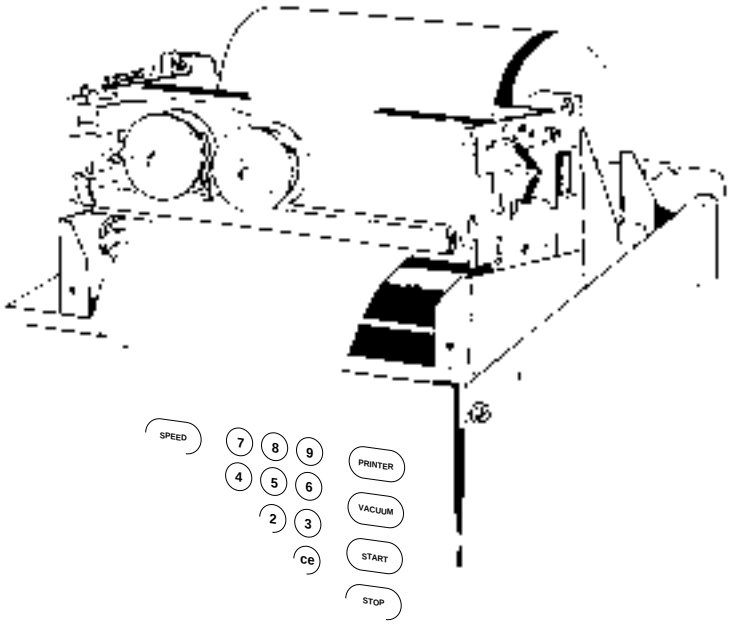


Figure 9-10. Ribbon Spools Installed

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) for detailed information on ordering parts and supplies. For your convenience, a partial list is given below.

Spinkote lubricant (2 oz)	306812
Silicone vacuum grease (1 oz)	335148
Beckman Solution 555 (1 qt)	339555
Chamber O-ring	801778
Logbook for Preparative Ultracentrifuges	330049
Master Rotor Logbook	339587
Direct-drive vacuum pump oil (1 L)	341661
Diffusion pump oil (250 cc)	330246
Roll of printer paper	927505
Printer ribbon	927506

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

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

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

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.

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

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