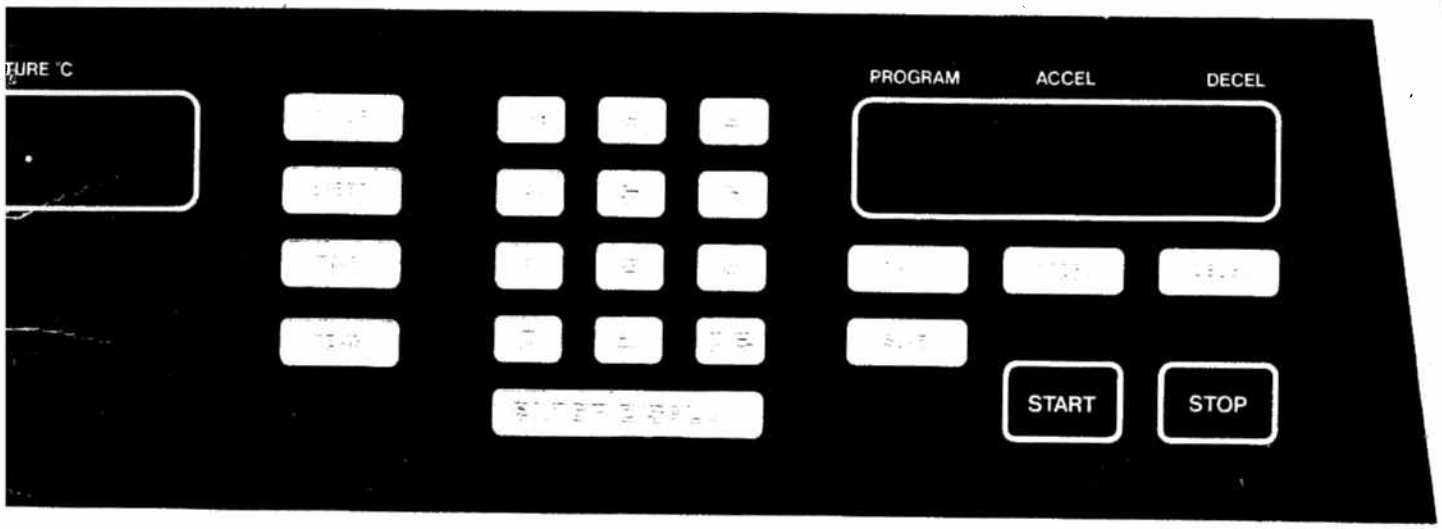
BECKMAN

TL-100

TABLETOP ULTRACENTRIFUGE

INSTRUCTION MANUAL

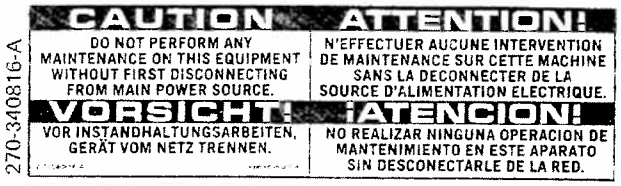


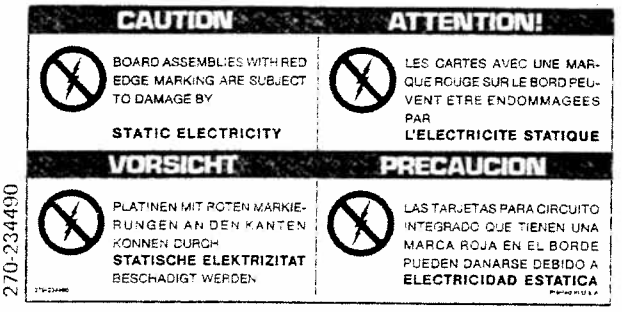
Safety Reminder

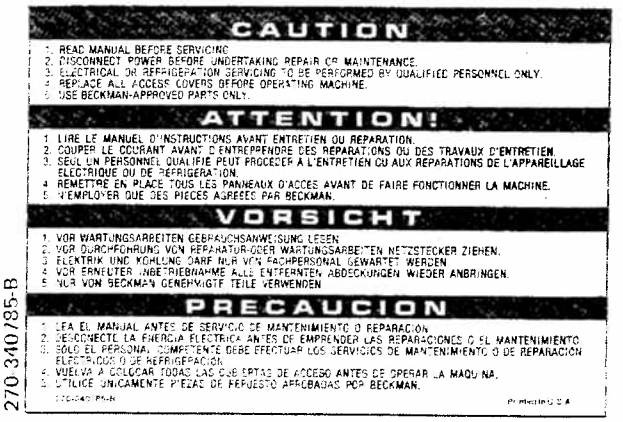
This page summarizes cautionary information basic to the safe operation of the TL-100 Tabletop Ultracentrifuge. However, it is strongly recommended that you read the entire manual carefully before attempting to operate the instrument.

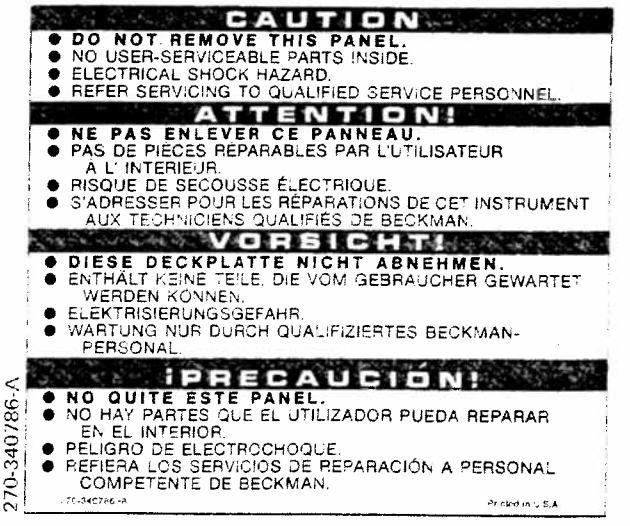
- The TL-100 Tabletop Ultracentrifuge is not designed for use with materials capable of developing flammable or explosive vapors. Such materials should not be handled or stored near the instrument.
- Spills may generate aerosols. Pathogenic, toxic, or radioactive materials should not be used in this instrument unless all necessary safety precautions are taken.
- Maintenance other than that contained in this manual should be performed only by trained, qualified personnel.
- Turn the POWER off and disconnect the instrument from the main power source before performing any maintenance that requires the removal of an instrument panel.
- 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.
- Under no circumstance should you try to slow or stop the rotor by hand.

Labels shown here are attached to the TL-100 Tabletop Ultracentrifuge. Replacement labels will be provided free of charge by writing to Beckman Instruments, Marketing Department, Box 10200, Palo Alto, California 94304.









TL-IM-3 July 1987

BECKMAN

TL-100

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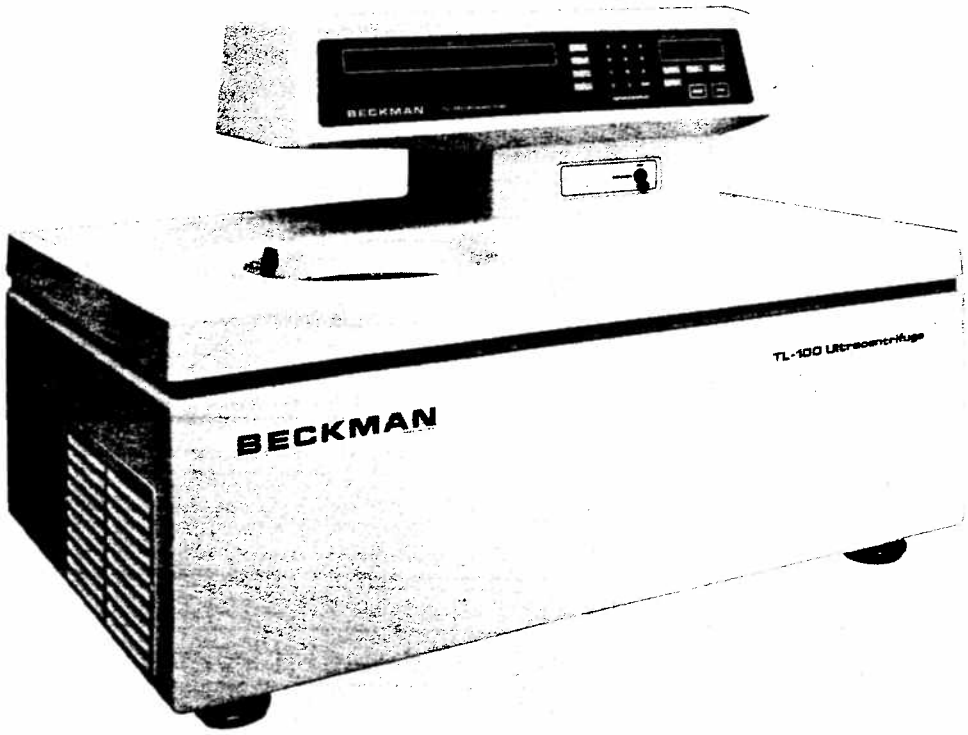


MJM-0688-.9-GL

PUBLISHED BY SPINCO DIVISION OF BECKMAN INSTRUMENTS, INC., PALO ALTO, CALIFORNIA 94304

Contents

Illustrations

Introduction

The TL-100 is a microprocessor-controlled tabletop ultracentrifuge, used to generate high centrifugal forces for the separation of particles in small sample volumes. Several rotors have been specially designed by Beckman for use in the TL-100.

This instrument design features a variable-frequency induction drive, thermoelectric temperature control system, self-purging vacuum system, automatic rotor identification system for overspeed protection, 10-program memory, and a choice of acceleration and deceleration rates.

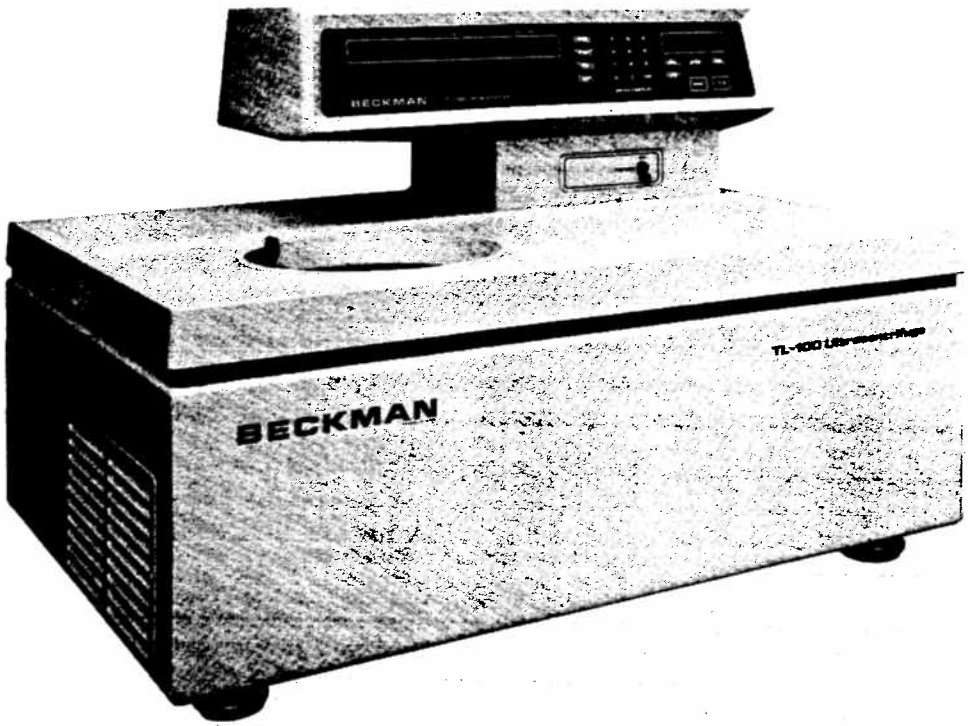
Digital displays indicate run parameters. The displays serve a dual purpose. When the power is turned on, they show the *actual* (real-time) operating conditions of the instrument. These real-time conditions are also shown during the run. When the instrument is being programmed (the input mode) the displays show the *set* values (those selected by the operator). These set values are retained in memory until new values are entered, and they can be recalled at any time.

Manual and programmed operation are available. In manual operation, the individual run parameters are entered by the operator before beginning the run. Programmed operation permits the fast and accurate duplication of runs at any time, using the 10-program memory.

User messages and audible signals will alert you to conditions that may need attention.

An optional feature of the instrument is the RS 232C Interface Accessory. Detailed information about this feature will be supplied upon request.

The following sections describe instrument specifications and components and provide detailed instructions on the operation and care of the TL-100 tabletop ultracentrifuge. Read the manual carefully, using the foldout illustration at the back to locate specific displays or switches.


BECKMAN
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Specifications

CONTROL CHARACTERISTICS

Speed	
Settable speed	5000 to 100 000 rpm in increments of 1000 rpm
Speed control	Actual rotor speed will be within 100 rpm of the set speed
Speed display	Digital readout indicates actual rotor speed in increments of 100 rpm at speeds above 5000 rpm and 10 rpm at speeds below 5000 rpm.
Rotor Temperature	
Settable temperature	2 to 40°C in increments of 1°C
Temperature control (after equilibration)	±2° of set temperature
Temperature display (after equilibration)	Digital readout indicates actual rotor temperature in increments of 0.1°C
Time	
Settable time	To 99 hours 59 minutes
Time display	Digital readout indicates time remaining in the run
Acceleration	10 acceleration rates: full acceleration and 9 slow acceleration rates from 0 to 5000 rpm, followed by full acceleration to set speed.
Deceleration	11 deceleration rates: full dynamic braking from set speed and 10 slow deceleration rates from 5000 to 0 rpm, including coasting to a stop without brake.
Operation	Manual or programmed. 10-program memory for accurate duplication of run parameters.

OPERATIONAL FEATURES

User Message	**Condition**
CPU	Microprocessor malfunction
PWR	Loss of power during run
SPD	Speed-related malfunction or rotor imbalance at high speeds
VAC	Chamber pressure over 500 microns or vacuum of 10 microns not reached within 20 minutes
TEMP	Excessive rotor temperature
DRIVE	Drive overheating
MBAL	Rotor imbalance at low speeds
DOOR	Door unlocked or open
Barrier Ring	¾-in. (19-mm) structural steel armor ring acts as a primary barrier, surrounded by a ½-in. (13-mm) steel secondary barrier ring to provide full protection for the operator.
Door	¼-in. (6.4-mm) structural steel
Vacuum	Diffusion pump in series with a mechanical pump reduces chamber pressure to below 10 microns (1.34 Pa).
RS 232C Accessory	Optional RS 232C Interface Accessory available.

Preinstallation Requirements

NOTE: Do not attempt to install this instrument. Its purchase price includes installation by Beckman personnel. Installation by anyone other than authorized Beckman personnel invalidates any warranty covering the instrument.

Preinstallation requirements have been sent prior to shipment of the instrument. The following information is provided in case the ultracentrifuge must be relocated.

ELECTRICAL REQUIREMENTS

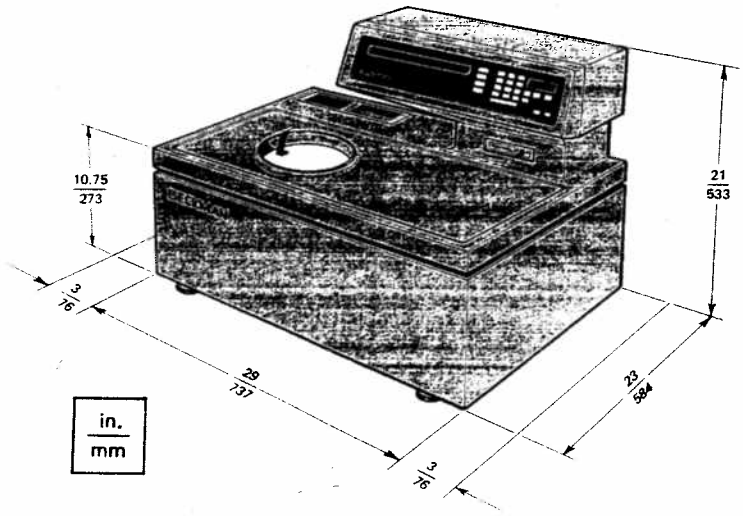
120-V instrument . . . . . 100-130 Vac, 13 A, 50/60 Hz
220-V instrument . . . . . 200-240 Vac, 6 A, 50/60 Hz

A 6-ft (1.8-m) power cord with plug is supplied with the instrument (to be attached to IEC 320/CEE-20 AC power connector at rear of instrument).

PHYSICAL DATA

Weight	205 lb (93 kg)
Height	21 in. (533 mm)
Width	29 in. (737 mm)
Depth	23 in. (584 mm)
Clearances (sides)	3 in. (76 mm)
Finish	Coated polycarbonate on control panel; urethane paint on top surface; general purpose paint on other surfaces
Maximum heat dissipation into the room	0.6 kW (2050 Btu/h)

If it is necessary to move the instrument, relocate it on a clean, level surface, such as a table or laboratory bench sturdy enough to support the weight of the ultracentrifuge. Place a level on the instrument door and adjust the instrument feet if necessary. Check that there are 3-in. clearances on both sides of the TL-100 to ensure sufficient air circulation. It is recommended that the instrument sit at least 2 inches from the edge of the table. The TL-100 will operate within specifications in a laboratory with an ambient temperature ranging from 15 to 35°C.



Description

The TL-100 Tabletop Ultracentrifuge is used to generate high centrifugal forces for the separation of particles in small sample volumes. The TL-100 must be used with the Beckman rotors specially designed for this instrument.

POWER SWITCH

The power switch controls electrical power to the instrument. This switch is also a circuit breaker and will trip to cut off power in the event of a power overload. The power must be turned ON before the chamber door can be opened.

CONTROL PANEL

Run parameters are selected using the touch switches on the control panel (see Figure 1). An audible beep signals when a switch has been pressed. The keypad is used for the numerical entry of run parameters.

User messages appear on the control panel to assist you in properly operating the instrument or to alert you to conditions that may need attention. These messages and recommended actions are described in detail in TROUBLESHOOTING.

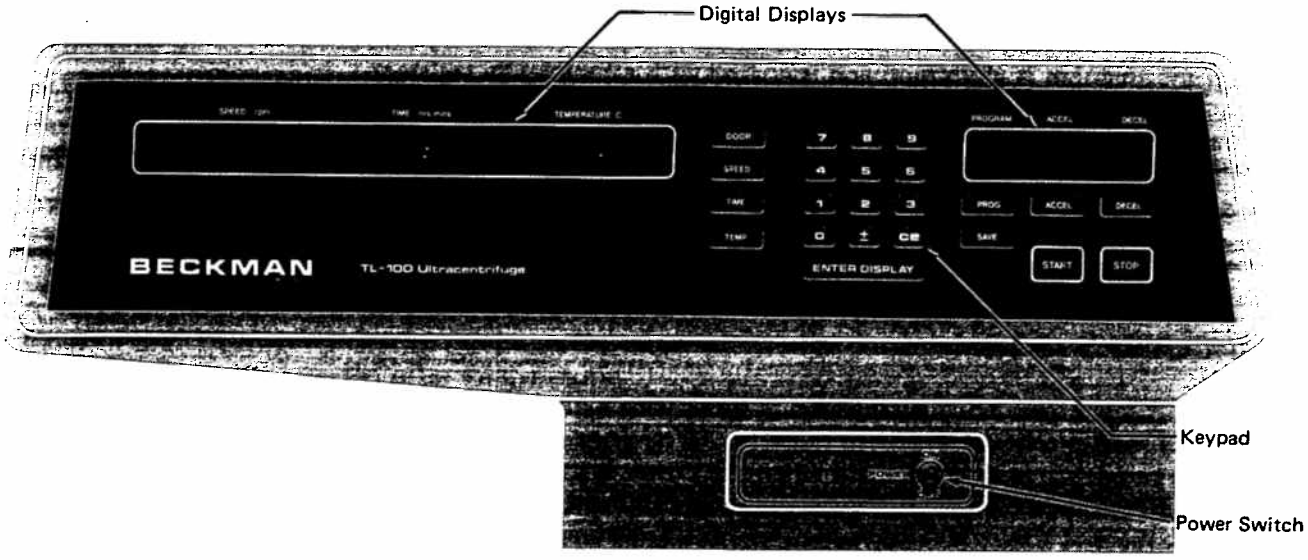


Figure 1. TL-100 Control Panel

DIGITAL DISPLAYS

Digital displays indicate rotor speed, run time, rotor temperature, selected program number, and numbers that represent selected acceleration and deceleration rates. The displays serve a dual purpose. When the power is turned on, they show the *actual* (real-time) operating conditions of the instrument. Real-time conditions are also displayed during the run, after START is pressed.

When the instrument is being programmed (the input mode), the displays show the *set* values (those selected by the operator). These set values are retained in memory until new values are entered, and they can be recalled at any time by pressing ENTER/DISPLAY. When ENTER/DISPLAY is pressed, the set values are shown for 5 seconds; the instrument then returns to displaying the real-time conditions.

When a run-parameter switch is pressed, the appropriate display flashes to indicate that data can be entered. The display continues to flash until ENTER/DISPLAY or the next run-parameter switch is pressed. If an unacceptable value is entered (for example, 4000 rpm for speed), the appropriate display flashes rapidly to indicate an operator error. The error must be cleared and an acceptable value entered.

DOOR

The door, made of ¼-in. (6.4-mm) structural steel, has an electromechanical door-locking mechanism to prevent operator contact with spinning rotors. When the door is closed it locks automatically. It can be unlocked only by pressing DOOR and opened only when the power is ON and the rotor is at rest.

In the event of a power failure, the door lock can be manually tripped for sample recovery (see TROUBLESHOOTING).

ROTOR CHAMBER

The rotor chamber is aluminum and is coated with a chemically resistant epoxy finish. The rotor drive hub and speed sensor are visible in the bottom of the chamber (Figure 2). A ¾-in. (19-mm) structural steel armor ring, surrounding the chamber, acts as a primary barrier. This in turn is surrounded by a ½-in. (13-mm) steel secondary barrier to provide full protection for the operator.

VACUUM SYSTEM

The instrument uses a diffusion pump in series with a mechanical vacuum pump to reduce chamber pressure to below 10 microns (1.34 Pa). The vacuum pump starts automatically when the power is turned on and the door is closed. The diffusion pump is automatically activated when chamber pressure reaches about 500 microns. The TL-100 features a self-purging system that continually removes moisture from the vacuum system while the instrument is on and the door is closed.

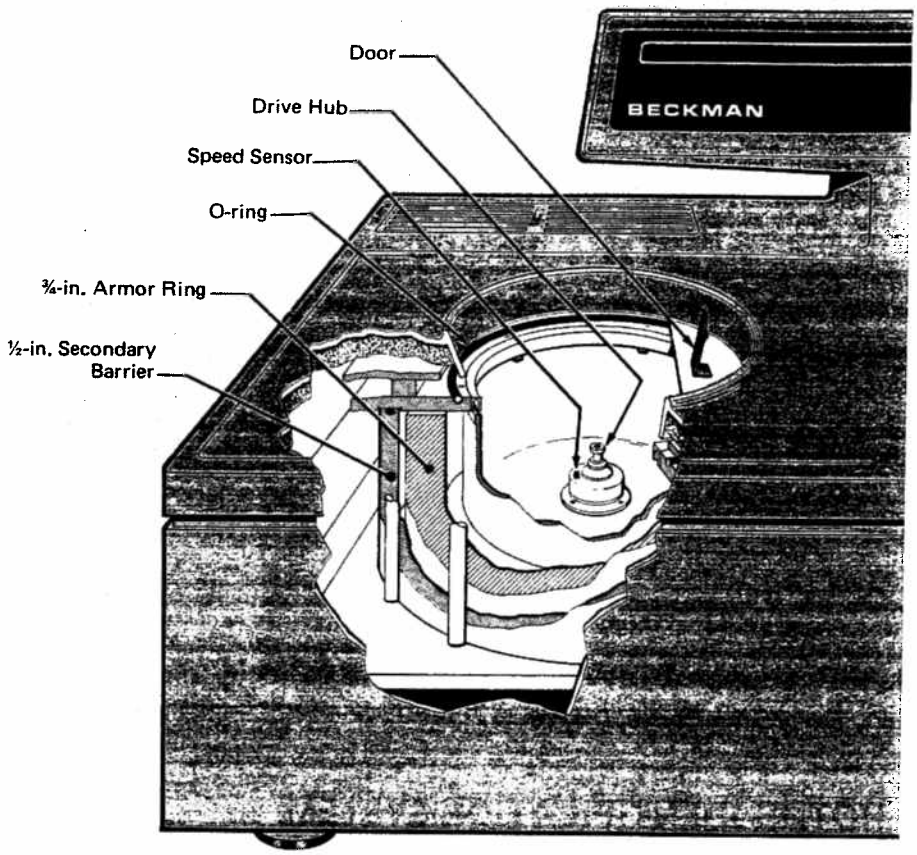


Figure 2. The Rotor Chamber

The VAC message appears on the control panel any time the power is on and the vacuum is above 500 microns. It also appears if a chamber pressure of 10 microns or less is not reached after 20 minutes. During the run, the VAC message will flash to indicate a loss of chamber pressure.

The vacuum is released by pressing DOOR while the rotor is at rest. If you decide not to open the door after pressing the switch, the vacuum system will automatically start again after 8 seconds.

TEMPERATURE SENSING

A sensor in the rotor chamber (not visible) continuously monitors chamber temperature. The microprocessor calculates the required chamber temperature to maintain the selected rotor temperature.

TEMPERATURE CONTROL SYSTEM

The TL-100 uses a solid state thermoelectric temperature control system, which eliminates the need for the more conventional refrigeration system and heater. Neither freon nor water is needed; the only coolant required is forced air.

After the power is turned on, the temperature control system will be activated when the door is closed and the vacuum system comes on.

The run temperature can be set between 2 and 40°C. If no set temperature is entered, the instrument automatically selects 25°C as its operating temperature.

Peak-to-peak fluctuations of rotor temperature (after reaching equilibrium) will be within ±0.1°C (see Figure 3).

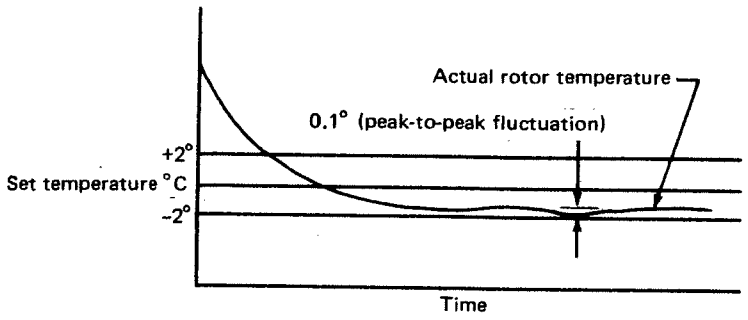


Figure 3. Temperature Control Diagram

OVERSPEED AND ROTOR IDENTIFICATION SYSTEM

The overspeed system is a safety feature that *continuously* monitors the rotor during centrifugation. The system includes a magnetic speed sensor in the rotor chamber (see Figure 2) and magnets on the bottom of each rotor. At 1500 rpm, the system identifies both the rotor type and maximum rotor speed. It compares the *set* speed with the *rotor's maximum permitted speed.* If the *set* speed is greater than the maximum permitted speed, the SPEED display begins to flash rapidly and the rotor decelerates to a stop. The error must be cleared and an appropriate speed entered before the run can be continued or restarted. Throughout the run, checks are made to ensure that the rotor does not exceed set speed. Should a speed-related problem occur, the user message [redacted] will appear. Consult TROUBLESHOOTING.

DRIVE

The TL-100 uses an air-cooled direct-drive induction motor. This drive is frequency-controlled, eliminating the need for gears and brushes. In addition, the drive does not require an oil vacuum seal or external oil reservoir. Externally cooled by forced air and internally cooled by oil, the TL-100 drive delivers ultra-smooth, quiet performance.

IMBALANCE DETECTION SYSTEM

Two imbalance detectors monitor the rotor during the run. At low speeds, an incorrectly loaded rotor can cause an imbalance. Rotor instability can also occur if the instrument is moved or if it is not resting level on the table or bench. See TROUBLESHOOTING.

NAME RATING PLATE

The name rating plate (Figure 4) for your TL-100 is affixed to the rear of the instrument. Always mention this serial number when corresponding with Beckman regarding your TL-100 ultracentrifuge.

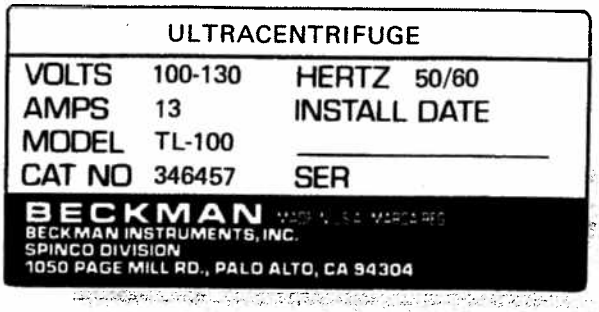
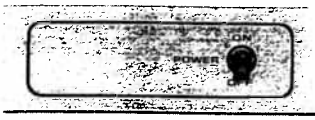


Figure 4. Typical Name Rating Plate

Run Preparation

This section explains how to use the control panel to enter the run parameters. Use the foldout illustration at the back of the manual to locate displays and switches on the control panel.



POWER

Turn the power switch ON. To end a run for any reason, do not turn the power switch off. Press [STOP] instead.

DOOR

NOTE: The power must always be turned ON before you can unlock and open the chamber door.

Press [DOOR] to unlock the door and vent the chamber. (The instrument will accept this command *only* when the rotor is at rest.) After the chamber has been vented (you can hear a slight hissing sound), use the door handle to slide the door open. Should you decide not to open the door after pressing the switch, the vacuum system will automatically start again after 8 seconds.

To unlock the door *after* you have pressed [START] (even if the rotor is still at rest), press [STOP] and then [DOOR].

To keep the chamber clean and dry, leave the door closed whenever possible. The DOOR message appears on the control panel and an intermittent beep sounds to remind you when the door is open. To clear these signals, close the door.

See TROUBLESHOOTING for instructions on opening the door in an emergency—such as during an extended power failure.

KEYPAD

- Use the keypad to enter numerical values for the run parameters.
- Use the keypad to enter *or* recall a desired program number and to select acceleration and deceleration rates.

In addition to keys for digits 0 through 9, there are keys for [ce] (clear entry) and [ENTER/DISPLAY].

ce CLEAR ENTRY KEY

The clear entry key operates *after* a run-parameter switch has been pressed and a value has been entered.

- Press [ce] once to clear a numerical entry; "0" will flash in the display. Reenter the correct numbers.

> Example: You want to enter 4:30 as your run time; however, you press [4] [1] [0] by mistake. Press [ce] once. "0" will flash in the display. Reenter [4] [3] [0] in that order.

- Press [ce] *twice* in succession to exit from the input mode entirely. The associated display stops flashing and returns to showing real-time conditions.
- Press [ACCEL], [ce], and another run-parameter switch *or* [ENTER/DISPLAY], to clear the ACCEL display.
- Press [DECEL], [ce], and another run-parameter switch *or* [ENTER/DISPLAY], to clear the DECEL display.
- Press [ce] to clear user messages following a shutdown condition. See TROUBLESHOOTING.

ENTER/DISPLAY ENTER/DISPLAY

- Press [ENTER/DISPLAY] to *enter* set values into memory. If a value is unacceptable (for example, 4000 rpm for speed), the display will flash rapidly to indicate the mistake. Clear the display by pressing [ce], and reenter an acceptable value.

> **NOTE:** [ENTER/DISPLAY] *must* be the last switch pressed before pressing [START] to begin the run.

- Press [ENTER/DISPLAY] at any time to *display* set values for 5 seconds.

RUN PARAMETERS

SPEED SPEED

The SPEED display indicates the speed of the rotor in revolutions per minute. Speeds between 0 and 5000 rpm are shown in increments of

10 (for example, 880 rpm). Speeds above 5000 rpm are shown in increments of 100 (for example, 60 500 rpm).

The run speed can be set between 5000 and 100 000 rpm in increments of 1000 rpm. When entering the set speed, the last three digits in the display are fixed as zeros and cannot be changed by keypad entries.

To enter run speed:

1. Press [SPEED]. The SPEED display will flash.
2. Use the keypad to enter the desired speed.

   Example: To enter 100 000 rpm, simply press [1] [0] [0] in that order. Remember, the last three digits of the display are fixed as zeros.

3. Check the SPEED display. If the entry is incorrect, press [ce], and reenter the correct digits.
4. Press the next run-parameter switch or [ENTER/DISPLAY]. If you entered a speed below 5000 rpm, the SPEED display will flash rapidly to indicate an operator error. Press [ce] and reenter an acceptable value. Then press the next run-parameter switch or [ENTER/DISPLAY] again.

The set speed can be changed at any time by repeating steps 1 through 4. The rotor will promptly accelerate or decelerate to the new speed.

At 1500 rpm, the TL-100 identifies the rotor and checks its maximum permitted speed. If the *set* speed is greater than the rotor's maximum allowable speed, the SPEED display will flash rapidly and the rotor will decelerate to a stop. To clear the error, press [ce] and reenter an acceptable run speed. Press [ENTER/DISPLAY] and [START] to restart the run.

If certain speed-related malfunctions occur during centrifugation, there will be a 20-minute delay before the user message SPD can be cleared and the door unlocked. This is to ensure that the rotor has come to a complete stop. Consult TROUBLESHOOTING.

TIME

During centrifugation, the TIME display indicates the time *remaining* in the run. Run time can be set for up to 99 hours and 59 minutes.

To enter run time:

1. Press [TIME]. The TIME display will flash.
2. Use the keypad to enter the desired time.

   Example: To enter a run time of 5 hours and 30 minutes, press [5] [3] [0] in that order.

3. Check the TIME display. If the entry is incorrect, press [ce] and reenter the correct value.

4. Press the next run-parameter switch or [ENTER/DISPLAY].

If you enter a number that is greater than 59 minutes, the instrument automatically recalculates the time in hours and minutes.

> Example: If you enter [9] [0] as your run time, the instrument will correct the entry to read [1] : [3] [0].

The TIME display begins counting down *when the rotor starts to spin.* The run automatically terminates when the set time reaches zero, and a beep sounds when the rotor has stopped.

Should the instrument shut down during the run, the TIME display stops counting and remains fixed at that time. By comparing this time with the set time, you can determine when in the run the shutdown occurred.

TEMPERATURE

The TEMPERATURE display indicates actual rotor temperature at thermoequilibrium. The run temperature can be set from 2 to 40°C. If no value is entered, the instrument automatically selects 25°C as the operating temperature. The actual temperature is displayed to a tenth of a degree, and is within ±2° of the set temperature (after equilibration). *For fast equilibration, refrigerate or warm the rotor to the desired temperature before the run.* For optimal temperature control during short runs, turn on the instrument 15 minutes before the first run.

To enter run temperature:

1. Press [TEMP]. The TEMPERATURE display will flash.

2. Use the keypad to enter the desired temperature.

> Example: to enter 20.0°C, press [2] [0] in that order. The place to the right of the decimal is fixed at zero.

3. Check the TEMPERATURE display. If the entry is incorrect, press [ce], and reenter the correct digits.

4. Press the next run-parameter switch or [ENTER/DISPLAY]. If an unacceptable temperature has been entered (1°C, for example), the TEMPERATURE display will flash rapidly to indicate the error. Press [ce] and reenter an acceptable value. Then press the next switch or [ENTER/DISPLAY] again.

The set temperature can be changed at any time by repeating the steps above. The rotor temperature will be adjusted accordingly.

If the rotor temperature rises more than 2°C above the set temperature or exceeds 40°C, the user message [TEMP] will flash on the control panel. If a run is in progress, the rotor will decelerate to a stop. Consult TROUBLESHOOTING.

ACCEL DECEL

ACCELERATION and DECELERATION

The TL-100 provides a choice of 10 acceleration rates to protect the gradient and sample-to-gradient interface and 11 deceleration rates to maintain optimum separation. The Table lists these rates by keypad number. The acceleration time is the time it takes a rotor to reach 5000 rpm from rest. At 5000 rpm, maximum acceleration takes over until the rotor reaches set speed. The deceleration time is the time it takes a rotor to decelerate from 5000 rpm to rest. From set speed to 5000 rpm, the rotor decelerates with full dynamic braking. If no keypad numbers are selected, the instrument automatically accelerates and decelerates at maximum rates and the ACCEL and DECEL displays remain blank.

Acceleration and Deceleration Rates

Keypad Number	ACCEL Time from 0 to 5000 rpm (minutes)	DECEL Time from 5000 to 0 rpm (minutes)
(blank)	¼*	¼*
1	½	1
2	1	1½
3	1½	2
4	2	2½
5	2½	3
6	3	4
7	3½	6
8	4	8
9	5	10
0		coasting stop from set speed without brake

*Maximum rate. If no digit is selected, the rotor will accelerate and/or decelerate at maximum rates. The display(s) will remain blank.

To select an acceleration rate:

1. Press [ACCEL]. The ACCEL display will flash.
2. Press the keypad number that represents the desired acceleration rate (see the Table). That number will appear in the display.

   Example: To select 1½ minutes as your acceleration time, press [3]. The number "3" will appear in the display.

3. Check that the entry is correct. If it is not, press [ce] and reenter the correct digit.
4. Press the next run-parameter switch or [ENTER/DISPLAY].

To clear the ACCEL display entirely, press [ACCEL], [ce], and another run-parameter switch *or* [ENTER/DISPLAY].

To select a deceleration rate:

1. Press [DECEL]. The DECEL display will flash.
2. Press the keypad number that represents the desired deceleration rate (see the Table). That number will appear in the display.

   Example: To select 2½ minutes as your deceleration time, press [4]. The number "4" will appear in the display.

3. Check that the entry is correct. If it is not, press [ce] and reenter the correct digit.
4. Press another switch or [ENTER/DISPLAY].

To clear the DECEL display altogether, press [DECEL], [ce], and another run-parameter switch *or* [ENTER/DISPLAY].

PROGRAM

SAVE

The TL-100 has an internal memory capable of holding up to 10 sets of run parameters. Each set, or program, is stored and can be recalled by keypad number (0 through 9). Programs are retained in memory even if the power is turned off. When necessary, a program can be modified for a particular run or changed permanently. Programs cannot be cleared using the [ce] key; the run conditions must be cleared.

To create a new program:

1. Press [PROG]. A dash will flash in the PROGRAM display.
2. Select a keypad number for the program. (Use this number any time you wish to recall the set of run parameters you are about to enter.)
3. Enter the desired run parameters to define *a complete run.*

   NOTE: DO NOT use [ENTER/DISPLAY] to enter keypad numbers. Pressing [ENTER/DISPLAY] at this time will enter the values into the microprocessor but *not* into the program memory.

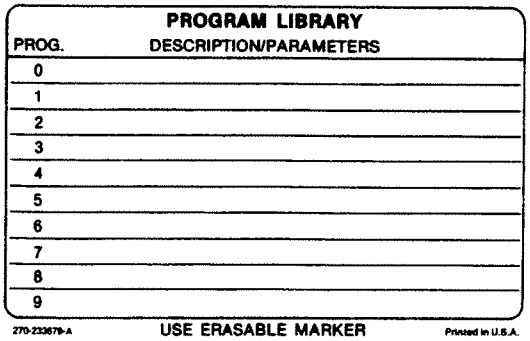
4. Press [SAVE]. The set values will be displayed for 5 seconds. *By pressing [SAVE], you have entered the program into memory.*
5. Now press [ENTER/DISPLAY] and [START] if you wish to begin the run.

NOTE: Erasable labels (Figure 5) are provided as a program library.

To recall a program:

The program can be recalled at any time by pressing [PROG] and the appropriate keypad number. The programmed run parameters will be displayed for 5 seconds. To begin this run, simply press [ENTER/DISPLAY] and [START].

As mentioned above, a program can be changed in memory or modified for a particular run. The first procedure changes the program permanently; the second permits change for a given run while leaving the program memory *unchanged.*



PROGRAM LIBRARY

PROG.	DESCRIPTION/PARAMETERS
0	
1	
2	
3	
4	
5	
6	
7	
8	
9	

270-23367-A USE ERASABLE MARKER Printed in U.S.A.

Figure 5. Erasable Program Label

To permanently change a program in memory:

1. Press [PROG]. Then enter the number of the program to be changed.
2. Press the run-parameter switch (for example, [SPEED]) to be changed. Both the PROGRAM display and the associated display will flash.
3. Use the keypad to enter the new value.

   NOTE: DO NOT use [ENTER/DISPLAY] to enter the keypad numbers. Pressing [ENTER/DISPLAY] at this time will enter the digits into the microprocessor but *not* into the program memory.

4. Repeat steps 2 and 3 if you wish to change any other run parameters. When all changes have been entered, press [SAVE]. The new program will be displayed for 5 seconds. This program will remain in memory until further changes are made. Remember to record the changes on your program library label.
5. To begin the run using this program, press [ENTER/DISPLAY] and [START].

To modify a program for a particular run:

1. Press [PROG] and the number of the program to be modified.
2. Press the run-parameter switch for the value to be changed.
3. Use the keypad to enter the new value.
4. Repeat steps 2 and 3 to make any further changes in the program.
5. Press [ENTER/DISPLAY]. The modified run will be displayed for 5 seconds.

6. Press ENTER/DISPLAY and START to begin now. (The program display goes blank to indicate that the instrument is not operating from the program memory at this time.)

Remember, you have modified the run parameters *for this particular run only. The program memory has not been changed.* When you next recall this program number, the original values will be displayed.

START

Press START to begin a run. The green light above the switch flashes until the vacuum reaches 500 microns; at this point, the rotor begins to spin and the light remains on until the end of the run.

> **NOTE:** To begin a run, ENTER/DISPLAY must always be the last switch pressed before pressing START. Further, you must press START while the set values are being displayed. If you wait beyond this time, the START switch will not activate. If this happens, press ENTER/DISPLAY and START again to begin the run.

If a run parameter has not been entered or a value cannot be accepted by the instrument, START will not be activated when pressed. Check each display and make any necessary corrections or additions. Press ENTER/DIDPLAY and START again to begin the run.

STOP

Press STOP to terminate a run for any reason. The green light above the switch will flash while the rotor decelerates. A long beep sounds when the rotor has come to a complete stop.

If you press START and then decide that you want to open the chamber door, you must press STOP before pressing DOOR (even if the rotor is at rest).

Run Procedure

This section summarizes manual and programmed operation. Use any of the rotors specially designed for the TL-100. Consult the appropriate rotor bulletin for instructions on preparing the rotor for centrifugation. For fast temperature equilibration, refrigerate or warm the rotor to the required temperature before the run. Remember that the power must be turned on in order to open the chamber door.

MANUAL OPERATION

1. Turn the power ON. Press [DOOR] to open the chamber door. Install the rotor according to directions in the rotor bulletin. Close the chamber door.
2. Enter the desired run parameters (SPEED, TIME, and TEMP).
3. Select ACCEL and/or DECEL rates if desired. (If no rate is selected, the instrument will automatically accelerate and decelerate the rotor at maximum rates.)
4. Press [ENTER/DISPLAY] and [START] to begin the run.

The run will end automatically when the time display counts down to zero. After the rotor has stopped (a beep will sound), press [DOOR] to unlock the door and vent the chamber. Remove the rotor. Keep the chamber door closed between runs.

To repeat this run, simply press [ENTER/DISPLAY] and [START]. There is no need to reenter any of the run parameters until you wish to make a change.

PROGRAMMED OPERATION

1. Turn the power ON. Press [DOOR] to open the chamber door. Install the rotor according to directions in the rotor bulletin. Close the chamber door.
2. Press [PROG] and the number representing the desired program.
3. Press [ENTER/DISPLAY] and [START] to begin the run.

The run will end automatically when the time display counts down to zero. After the rotor has stopped (a beep sounds), press [DOOR] to unlock the door and vent the chamber. Remove the rotor. Keep the chamber door closed between runs.

Manual Override During a Programmed Run

Any of the run parameters can be changed while a programmed run is in progress. However, such changes affect only the current run—*they do not affect the program memory.*

To change a run condition during a programmed run:

1. Press the run-parameter switch (for example, SPEED) to be changed.
2. Enter the new value.
3. Press ENTER/DISPLAY.

The run will be modified accordingly. The number in the PROGRAM display goes out to indicate that the instrument is no longer operating from the program memory.

POINTS TO REMEMBER

- Keep the chamber door closed whenever possible. This helps to maintain maximum performance of the vacuum system.
- Refer to the appropriate rotor bulletin for complete instructions on rotor care.
- For fast temperature equilibration, refrigerate or warm the rotor to the desired temperature before the run.
- Refer to TROUBLESHOOTING if a user message flashes on the control panel during the run.

Troubleshooting

IN CASE OF POWER FAILURE DURING THE RUN

If facility power fails only momentarily, the TL-100 will resume operation when power is restored and the rotor will return to set speed. If the rotor came to a complete stop, however, you will have to restart the run when the power is restored. In either case, the message PWR will flash on the control panel to indicate that a power outage has occurred.

CAUTION

Implement the following procedure only when absolutely necessary.

In the event of an extended power failure, it may be necessary to trip the door-locking mechanism manually to remove the rotor. DISCONNECT THE POWER CORD; then unscrew the two screws to remove the door handle. Remove the three screws on each side of the top instrument panel and slide the panel housing toward you to remove it (as shown in Figure 6). LISTEN CAREFULLY. *Do not proceed if there is any sound or vibration is coming from the drive.*

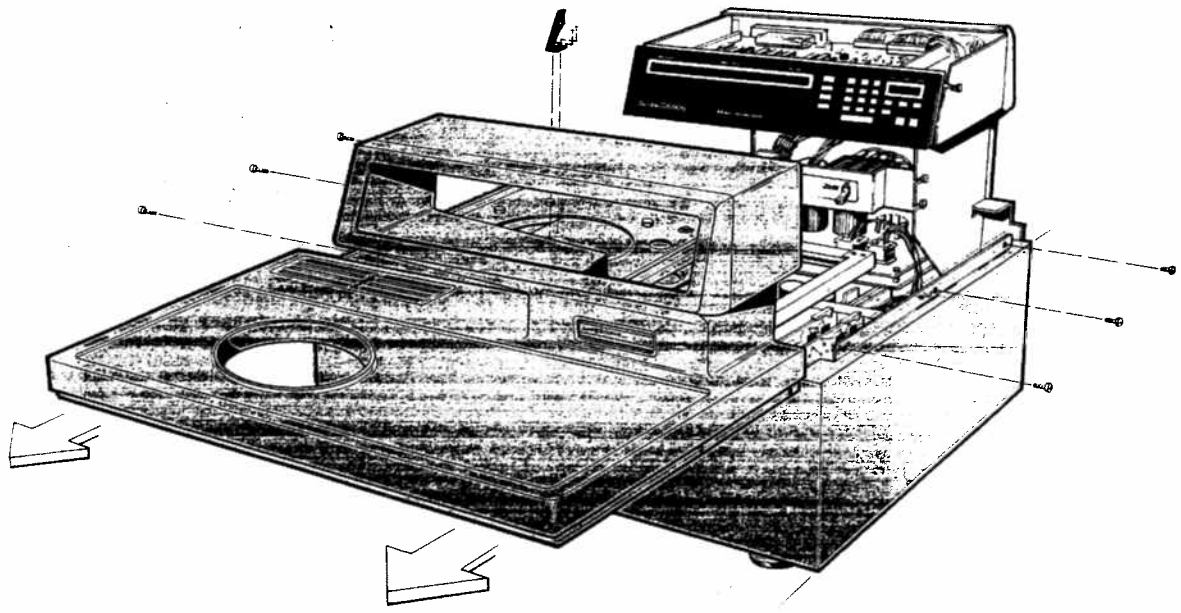


Figure 6. Removing the Top Panel of the Instrument

Release chamber vacuum by turning the screw clockwise on the vacuum solenoid valve (Figure 7) until you hear air rushing into the chamber. (If a whining noise is heard, close the valve and wait a little longer—the rotor is still spinning). After the vacuum is vented, return the screw counterclockwise to its closed position. To open the door, insert a screwdriver or pencil through the small hole in the chamber plate and depress the spring-loaded pin. With your other hand pull back on the door to slide it open. If the rotor is still spinning, close the door and wait. The drive is particularly quiet and may emit no audible sounds below 10 000 rpm.

WARNING

Under no circumstances should you try to slow or stop the rotor by hand.

After removing the rotor, replace the top panel and door handle by following the instructions above in reverse order.

CIRCUIT BREAKER

If the circuit breaker on the instrument trips repeatedly, call your Beckman Field Service Representative for assistance.

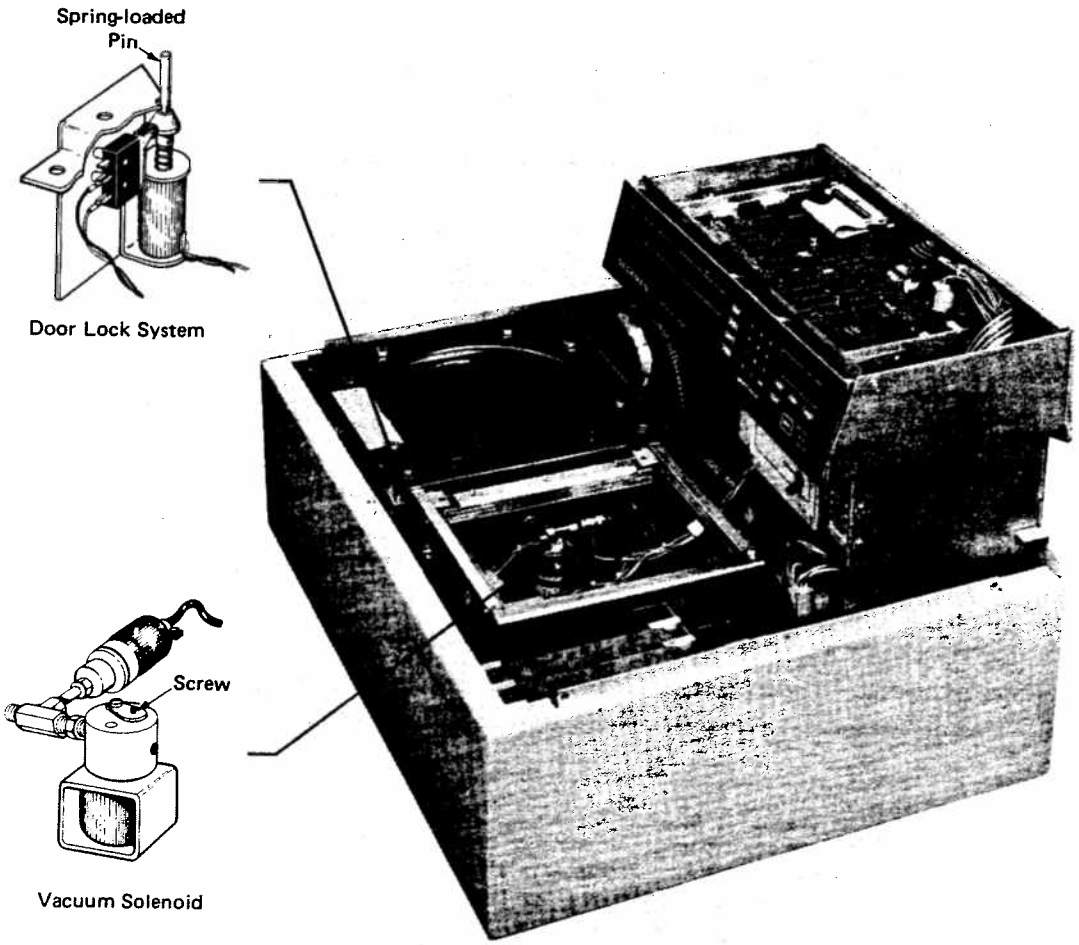


Figure 7. Door Lock System

USER MESSAGES

User messages appear on the control panel (see Figure 8) to communicate information about the instrument or to alert you to abnormal conditions that need attention. In the first instance, the message *shines continuously* until the condition changes. For example, when the instrument is turned on, [redacted] appears on the panel to indicate that the chamber pressure is above 500 microns. Once the pressure is below 500 microns, the message goes out.

A number of the messages indicate "shutdown" conditions, which cause the rotor to decelerate to a stop. The appropriate message(s) will *flash* until the condition is corrected and the message is cleared (press ce to clear it). An intermittent beep will sound for 10 seconds to alert you that a shutdown has occurred. Consult the User Messages Chart below to determine the nature of the condition and the recommended action.

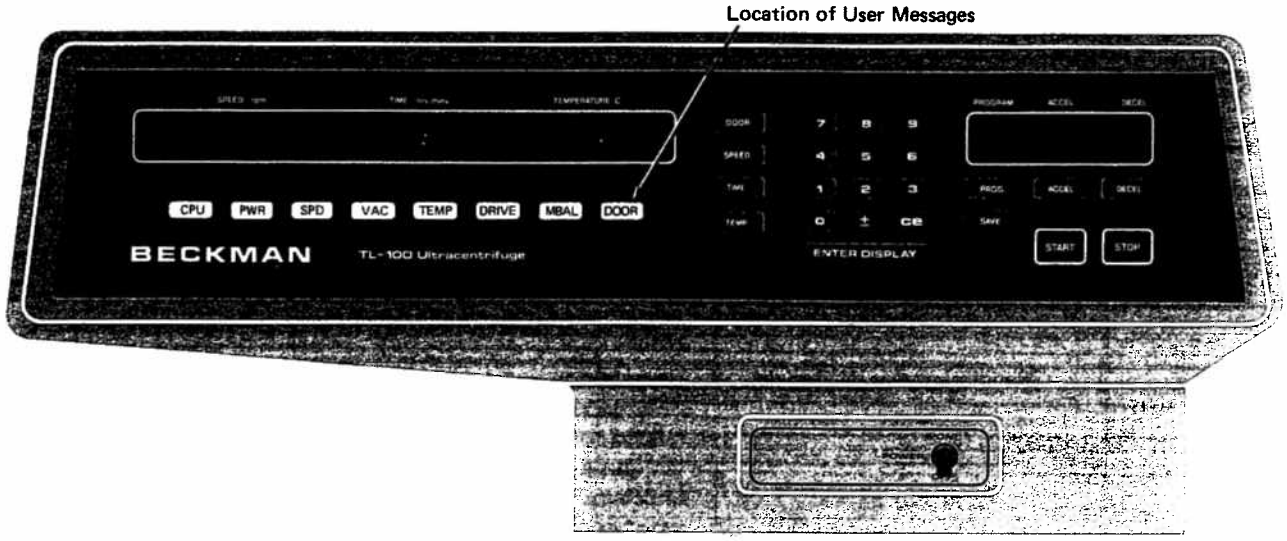


Figure 8. Location of User Messages on Control Panel

USER MESSAGES CHART

User Message	Definition	Result, Possible Causes and Recommended Action
CPU	Microprocessor malfunction or loss of program memory.	*Deceleration without brake.* No operator solution. (In the case of loss of program memory, the instrument is still functional.) Call your Beckman Field Service Representative.
PWR	Loss of power during centrifugation.	*Deceleration without brake.* A power outage has occurred during the run. If power is restored while the rotor is still spinning, the run will resume and the rotor will return to set speed. If the rotor came to a stop, however, the run will have to be restarted by the operator. In either case, PWR will remain flashing to indicate the outage. Press ce to clear the message.
SPD	Speed-related malfunction.	*Deceleration without brake.* This message can indicate several speed-related conditions, including: (1) run started without a rotor in the chamber; (2) rotor imbalance at high speed; (3) rotor overspeeding; or (4) unreliable speed signal. In *all* cases, shutdown of the instrument will result. Certain unreliable speed signals or a rotor imbalance at high speeds also results in a 20-minute delay before the message can be cleared and the door opened. The delay is to ensure that the rotor has stopped. The power MUST be left on so the instrument can calculate when the delay period is completed. If SPD flashes on the panel, check the following: (1) has a rotor been properly installed in the instrument; (2) is the instrument resting on a level surface or has it been moved (a high-speed imbalance can result if the instrument is not level or if it has been moved during operation); and (3) have the magnets on the rotor bottom been damaged. Press ce to clear the message. If SPD persists, call your Beckman Field Service Representative.

User Message	Definition	Result, Possible Causes and Recommended Action
VAC	Loss of chamber vacuum.	*Deceleration with brake.* The VAC message *appears* any time the door is open or the chamber pressure is above 500 microns. The message goes off as soon as the pressure is below 500 microns. If a pressure of 10 microns or less cannot be achieved in 20 minutes, the message reappears. If the pressure goes above 500 microns during centrifugation, the VAC message will begin to *flash.* Press ce to clear the message. Check that the chamber O-ring is undamaged and properly lubricated. Check for sample leakage, and clean the rotor and chamber if necessary (see MAINTENANCE). The vacuum pump may have moisture contamination. Leave the instrument on (with the door closed) for about 3 hours (or overnight) to permit the pump to purge itself of moisture. If the VAC message continues to flash when you attempt to restart the run, call your Beckman Field Service Representative.
TEMP	Excessive or uncontrolled rotor temperature.	*Deceleration with brake.* Press ce to clear the message. If the message reappears, call your Beckman Field Service Representative.
DRIVE	Drive has overheated.	*Deceleration with brake.* Check to see if the air intake louvers are blocked. Clean them (see MAINTENANCE). Press ce to clear the message. If the message reappears when you restart the run, call your Beckman Field Service Representative.
MBAL	Imbalanced rotor at low speeds.	*Deceleration with brake.* Press ce to clear the message. Press DOOR to vent the chamber and open the door. Check for proper balance and placement of buckets and tubes.
DOOR	Door open or unlocked.	*Deceleration with brake.* The message *appears* any time the chamber door is unlocked or open. Close the door properly before beginning the run. If DOOR *flashes* during centrifugation, there has been a door lock malfunction. When the rotor has stopped, check the door and the chamber O-ring. If there is no obvious cause for the message, call your Beckman Field Service Representative.

Maintenance

The following procedures should be performed routinely. For maintenance not covered in this manual, contact your Beckman Field Service Representative. User messages are discussed under TROUBLESHOOTING.

INSTRUMENT CARE

WARNING

Maintenance that requires the removal of instrument panels will involve exposure to electrical hazards. TURN THE POWER SWITCH OFF AND DISCONNECT THE INSTRUMENT FROM THE MAIN POWER SOURCE before removing any panel.

Do not use alcohol or other flammable substances in or near operating ultracentrifuges.

VACUUM SYSTEM

For optimum performance of the vacuum system, keep the area around the chamber O-ring clean. It can be wiped with a cloth or washed with a mild detergent. The O-ring should be cleaned with alcohol and a lint-free tissue and lightly coated with silicone vacuum grease every 3 or 4 months. If the O-ring becomes damaged, replace it as follows.

Remove the old O-ring with a blunt tool, being careful not to scratch the instrument. Clean the groove and surrounding surface area. Apply silicone vacuum grease to the new O-ring and place it into the groove near the door. With one thumb hold the O-ring down (where it meets the door) while using your other hand to stretch it across the chamber (see Figure 9). The stretching action will force the O-ring into place under the door. Now insert the rest of the O-ring into the groove.

Figure 9. Replacing the Chamber O-ring

If a chamber pressure of 500 microns cannot be reached in about 3 mintues, there may be moisture in the vacuum pump oil. To purge the vacuum pump of moisture, leave the instrument ON with the door closed for about 3 hours or, if convenient, overnight. Call your Beckman Field Service Representative to change the vacuum oil if it remains contaminated (you will continue to get a VAC message after following the instructions above).

DRIVE HUB

Lubricate the drive hub with a light coat of Spinkote™ about once a month.

AIR-INTAKE AND EXHAUST LOUVERS

Routinely check that the air-intake and exhaust louvers are clean and unblocked. Use a vacuum cleaner or damp cloth to keep them clean. An optional air-intake filter is available (see SUPPLY LIST).

CLEANING

All instrument surfaces can be kept clean by washing with a mild detergent solution such as Beckman Solution 555™. The top working surface is finished with urethane paint; the sides are finished with general purpose paint. Both can be disinfected with 70% ethanol in the event of contamination. The control panel is coated polycarbonate; use a mild detergent to clean it.

ROTOR CARE

Consult the appropriate rotor bulletin and the chemical resistances chart (publication IN-175) for instructions on the use and care of the rotors and their accessories. These bulletins also include a list of available tubes and other rotor accessories.

SUPPLY LIST

Chamber O-ring	889164
Air-intake filter	347397
Spinkote lubricant	306812
Silicone vacuum grease	335148
Beckman Solution 555	339555
TLA-100 fixed angle rotor package	343837
TLA-100.1 fixed angle rotor package	343838
TLA-100.2 fixed angle rotor package	343839
TLA-100.3 fixed angle rotor package	349490
TLS-55 swinging bucket rotor package	346134
TLV-100 vertical tube rotor package	347375
Rotor cleaning brush	347404
RS 232 Interface to IBM Computer	354531

Warranty for the TL-100 Tabletop Ultracentrifuge

Subject to the exceptions and upon the conditions specified below, Beckman 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 TL-100 Tabletop Ultracentrifuge (the product), to the original Buyer by Beckman or by an authorized representative, provided that investigation and factory inspection by Beckman 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. A complete list of such components or accessories is maintained at the factory and at each Beckman District Sales Office. The lists applicable to the products sold hereunder shall be deemed to be part of this warranty. If any such component or accessory fails to give reasonable service for a reasonable period of time, Beckman 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.

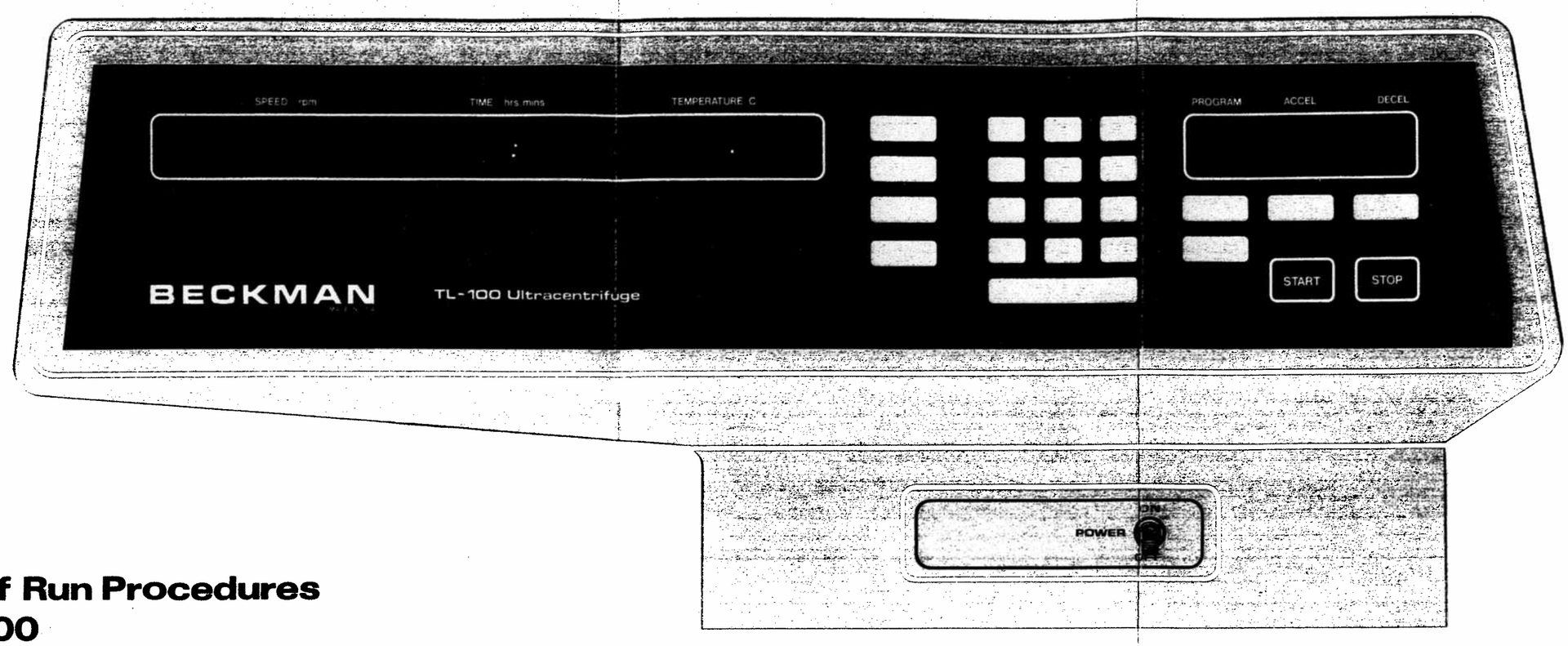
Any product claimed to be defective must, if requested by Beckman, be returned to the factory, transportation charges prepaid, and will be returned to Buyer with the transportation charges collect unless the product is found to be defective in which case Beckman will pay all transportation charges.

Beckman makes no warranty concerning products or accessories not manufactured by it. In the event of failure of any such product or accessory, Beckman 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.

Subject to the exceptions and upon the conditions specified below, Beckman agrees to correct, either by repair, or, at its election, by replacement, any defects of material or workmanship which develop within five (5) years after delivery of the TL-100 rotors (the product(s)), to the original Buyer by Beckman or by an authorized representative, provided that investigation and factory inspection by Beckman discloses that such defect developed under normal and proper use.

Beckman shall be released from all obligations under all warranties, either expressed or implied, if the product(s) covered hereby are repaired or modified by persons other than its own authorized service personnel, unless such repair by others is made with the written consent of Beckman, or unless such repair in the sole opinion of Beckman is minor, or unless such modification is merely the installation of a new Beckman plug-in component for such product(s).

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 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.



Summary of Run Procedures for the TL-100 Tabletop Ultracentrifuge

Consult the appropriate rotor bulletin for instructions on preparing the rotor for centrifugation. For fast temperature equilibration, refrigerate or warm the rotor to the required temperature before the run.

Turn the power ON. Press [DOOR] to open the chamber door. Install the rotor according to directions in the rotor bulletin. Close the chamber door.

TO START A MANUAL RUN

1. Enter the desired run parameters (SPEED, TIME, and TEMP).
2. Select ACCEL and/or DECEL rates if desired. (If no rate is selected, the instrument will use maximum rates.)
3. Press [ENTER/DISPLAY] and [START].

To repeat this run, simply press [ENTER/DISPLAY] and [START].

TO START A PROGRAMMED RUN

1. Press [PROG] and the number representing the desired program.
2. Press [ENTER/DISPLAY] and [START] to begin the run.

Changing Run Parameters During a Programmed Run

Changes made during a programmed run affect only the run in progress—they *do not* affect the program memory.

1. Press the run-parameter switch to be changed.
2. Enter the new value.
3. Press [ENTER/DISPLAY].

The run will be modified accordingly.

TO END A RUN

A run will end automatically when the time display counts down to zero. After the rotor has stopped (a beep sounds), press [DOOR] to unlock the door and vent the chamber.

TO SET UP A PROGRAM

Up to 10 programs can be stored and recalled by keypad number (0 through 9). Programs are retained in memory even if the power is turned off. Programs cannot be cleared using the [ce] key; the individual run conditions must be cleared.

To Create a New Program:

1. Press [PROG].
2. Use the keypad to enter a number for this program.
3. Enter the desired run parameters to define *a complete run.*

   NOTE: DO NOT use [ENTER/DISPLAY] to enter keypad numbers. Pressing [ENTER/DISPLAY] at this time will enter the values into the microprocessor but *not* into the program memory.

4. Press [SAVE].
5. Now press [ENTER/DISPLAY] and [START] if you wish to begin the run.

To Recall a Program:

Recall a program by pressing [PROG] and the appropriate keypad number. To begin this run, simply press [ENTER/DISPLAY] and [START].

To Permanently Change a Program in Memory:

1. Press [PROG]. Enter the number of the program to be changed.
2. Press the run-parameter switch to be changed.
3. Use the keypad to enter the new value.

   NOTE: DO NOT use [ENTER/DISPLAY] to enter the keypad numbers.

4. Repeat steps 2 and 3 if you wish to change any other run parameters.
5. When all changes have been entered, press [SAVE]. The revised program is now in the program memory. (Record the changes on your program library label.)
6. To begin this run, press [ENTER/DISPLAY] and [START].