

SORVALL®

SORVALL® Evolution™ *RC*

OPERATING INSTRUCTIONS



OPERATING INSTRUCTIONS

SORVALL® Evolution™ RC ***Superspeed Centrifuge***

Kendro Laboratory Products
Newtown, Connecticut
U.S.A.

SORVALL®  Kendro

This manual is a guide for use of the

SORVALL® Evolution™ RC Superspeed Centrifuge

Data herein has been verified and is believed adequate for the intended use of the system. Always follow the recommendations set forth herein; failure to do so could result in personal injury or property damage. Kendro does not guarantee results and assumes no obligation for the performance of products that are not used in accordance with the instructions provided. This publication is not a license to operate under, nor a recommendation to infringe upon, any process patents.

Warnings, cautions, and notes within the text of these instructions are used to emphasize important and critical instructions.

WARNING: Informs the operator of a hazard or an unsafe practice that could result in personal injury, affect the operator's health, or contaminate the environment.

CAUTION: Informs the operator of an unsafe practice that could result in damage of equipment.

NOTE: Highlights essential information.

Warnings and cautions appear in the left sidebar near the information to which they correspond and are accompanied by the hazard symbol .

Important Safety Information

Certain potentially dangerous conditions are inherent in the use of all centrifugation systems. To ensure safe operation of this system, anyone using it should be aware of all safe practices and take all precautions described below and throughout these operating instructions.



WARNING

Use specified Sorvall® rotors only. Use of another manufacturer's rotor can cause rotor failure which could result in personal injury and/or centrifuge damage.

When using radioactive, toxic, or pathogenic materials, be aware of all characteristics of the materials and the hazards associated with them in the event leakage or rotor failure occurs during centrifugation, in which case neither the centrifuge nor the rotor can protect you from particles dispersed in the air. To protect yourself, we recommend additional precautions be taken to prevent exposure to these materials, e.g., use of controlled ventilation or isolation areas.

Always be aware of the possibility of contamination when using radioactive, toxic, or pathogenic materials. Take all necessary precautions and use appropriate decontamination procedures if exposure occurs.

The use of sealed rotors, buckets and/or sample containers will provide increased protection from contamination during routine operation. However, these items will not guarantee contamination protection from accidents resulting in damage to the rotor or buckets. Do not run hazardous materials in the centrifuge unless placed in a biohazard enclosure and operated using all appropriate safety precautions.

Never use any material capable of producing flammable or explosive vapors or creating extreme exothermic reactions.

Never exceed the maximum rated speed of the installed rotor. To do so can cause rotor failure which could result in personal injury and/or centrifuge damage.

Always reduce (derate) rotor speed whenever:

- the rotor speed/temperature combination exceeds the solubility of the gradient material and would cause it to precipitate;
- rotor compartment load exceeds the maximum allowable compartment load specified (check this whenever average fluid density is greater than 1.2 g/ml). See Chapter 4, Operation.

Failure to reduce rotor speed under these conditions can cause rotor failure.

Centrifuges routinely deal with high energy levels and could move suddenly in the unlikely event of a rotor failure. During centrifuge operation, never lean on or move the centrifuge, keep the work surfaces and surrounding area clear of objects (including all hazardous materials), and do not work on top of or next to the centrifuge. See Chapter 2, Installation.

(continued)

Important Safety Information (cont.)



CAUTION

Do not run or precool a rotor at the critical speed as this will have a detrimental effect on centrifuge component life. See Rotor Information on page A-2.

Do not operate the centrifuge without a rotor properly installed and locked to the centrifuge drive. See the rotor instruction manual.

The centrifuge must be on a level surface and the front stabilizers lowered in order to minimize centrifuge movement in the event of a rotor failure. See Chapter 2, Installation.

The centrifuge can be damaged if connected to a voltage outside the range specified for this centrifuge. Check the voltage before plugging the centrifuge into a power source. See Chapter 2, Installation.

Always maintain the centrifuge in the recommended manner. See Chapter 5, Maintenance.

Table of Contents

Important Safety Information	iii
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Chapter 1: Introduction and Description

General Description	1-1
Centrifuge Features	1-1
Centrifuge Specifications	1-4

Chapter 2: Installation

Inspection	2-1
Location	2-1
Environmental Conditions	2-2
Electrical	2-2
Levelling	2-3

Chapter 3: Controls

Control Panel	3-1
Rotor Display and Controls	3-3
Time Display and Controls	3-4
Speed Display and Controls	3-5
Temperature Display and Controls	3-6
Start and Stop	3-7

Chapter 4: Operation

Startup Procedure	
• Step 1—Power on the Centrifuge	4-1
• Step 2—Identify and Load the Rotor	4-1
• Step 3—Set the Time Parameters	4-3
• Step 4—Set the Speed Parameters (rpm/RCF)	4-3
• Step 5—Set the Temperature (°C)	4-4
• Step 6—Start the Run	4-4
Rotor Precool/Preheat (Optional)	4-4
Once the Run is in Progress	
• Slow-Start/Slow-Stop	4-4
• Changing the Run Parameters	4-5
• Safe Speed System	4-5
• Stopping the Run	4-5
If a Power Outage Occurs	4-6
Reducing Speed for Rotor Compartment Loads	
in Excess of Design Mass	4-6
• Energy Management System	4-6
Continuous Flow Operation	4-7

Chapter 5: Maintenance

Cleaning	5-2
Lubrication	5-2
Emergency Sample Recovery	5-3
Parts Ordering Information	5-3
Service Decontamination Policy	5-4

Chapter 6: Messages and Diagnostics

Run Status Indicators	6-1
Informational and Error Messages	6-1

Appendix

Rotor Information	A-2
Warranty	A-3

List of Illustrations

1-1. Evolution™ RC Parts Location and Identification	1-3
2-1. Centrifuge Dimensions	2-1
2-2. Leveling Adjustment	2-3
2-3. Control Panel Adjustment	2-4
3-1. Control Panel	3-2
4-1. Rotor/Message Display at Startup	4-1
4-2. Evolution™ RC Tubing Holder	4-7
5-1. Door Interlock Override	5-3

List of Tables

5-1. Maintenance Schedule	5-1
6-1. Evolution™ RC Error Messages	6-3
Rotor Information	A-2

Chapter 1: Introduction and Description

This guide provides you with the information you need to install, operate and maintain your SORVALL® Evolution™ RC Superspeed Centrifuge. If you encounter any problems concerning either operation or maintenance that is not covered in the manual, please telephone Kendro for assistance. In the United States, call toll-free 800-522-7746. Outside the United States, the nearest Kendro office (see back cover) or your representative for SORVALL® products. As an additional source, please visit our internet web site at <http://www.kendro.com> or <http://www.kendro.de> for immediate access to information regarding this and other Kendro product offerings.

General Description

The SORVALL® Evolution™ RC Superspeed Centrifuge sets a new standard in superspeed performance and usability. With its powerful drive system, ergonomic design and the functionality you need for a basic centrifuge, it is the next step in the evolution of superspeed centrifuges.

When used with a SORVALL® SE-12 rotor, the Evolution™ RC can reach a top speed of 26 000 rpm with a maximum RCF (relative centrifugal force, or g-force) of 70 450. The Evolution™ RC accepts all SORVALL® Superspeed and *Supraspeed*® rotors with the exception of the S-20 *Supraspeed*® swinging-bucket rotors or the SH-MT horizontal microtube rotor.

Centrifuge Features

High Capacity

With the Evolution™ RC's high capacity rotor chamber, you can perform six-liter runs at up to 8500 rpm (15 810 g) in as little as nine minutes using the SLC-6000 Composite Rotor.

High Performance Drive

The Evolution™ RC's brushless DC direct drive system is designed for speed, accuracy, long life, and low maintenance — and no vacuum system is required to achieve high performance. Virtually pulse-free, it is inherently non-cogging, which ensures the smoothest acceleration and deceleration possible. (Cogging is typical of induction and brush type motors and can cause sample disturbance during acceleration and deceleration.) Features include:

- Three acceleration options and four braking options, with settings for full torque acceleration and braking performance that can deliver among the shortest run times in the industry.
- Rotor-specific imbalance thresholds which allow “eyeball balance” convenience.

Ergonomic Design

The Evolution™ RC is ergonomically designed for operator convenience. Features include:

- Low rotor-liftover height and short reach to controls
- Large display for across-the-room viewing with dual display of set and actual parameters
- An adjustable, low-glare control panel that may be purchased with either rotary knobs or scroll keys for setting run parameters
- An easy-glide chamber door that retracts and disappears behind the top deck, making the chamber easy to access
- Rubberized pads on either side of the door provide a slip-free surface for placing rotors and related equipment prior to loading.
- Convenient rotor lid holder at the top of the control console.

Precise Temperature Control

The Evolution™ RC's DuoTherm™ refrigeration system combines heating and cooling with accurate temperature control from +2°C to +40°C in run mode and from +2°C to +30°C in standby mode. The DuoTherm™ system offers quick temperature change response and precise temperature control. Rotors may be precooled or preheated.

Installation

With a narrow 28 inch (710 mm) width, the Evolution™ RC is smaller than most superspeed and ultraspeed centrifuges and therefore requires less floor space. Its high-strength frame is designed to limit centrifuge movement in the event of possible rotor failure. As a result, the Evolution™ RC does not need to be bolted to the floor, unlike other superspeed centrifuges.

Easy Rotor Identification

There is no need to memorize rotor codes with the Evolution™ RC. Rotors are listed on the display panel by name and type — you simply select from the list. RunBrowser™ lets you quickly recall the parameters for the last five runs, a timesaver if you regularly use the same settings.

Run Options

The Evolution™ RC provides the basic functionality you need for most centrifuge operations — speed, time and temperature — so that run parameters can be set quickly and easily. Run options include the following:

- RCF Run — RCF can be chosen in place of rpm to control run speed. This allows RCF to be reproduced from run to run and rotor to rotor.
- Accel/Brake — Multiple settings for automatic control of slow-start acceleration rate and slow-stop braking rate, for minimizing gradient or pellet disturbance.

- Continuous Flow Runs — With the SORVALL® TZ-28/GK or SS-34/KSB-R rotors.

Expanded Voltage Range

Configured and installed and by a Kendro service representative according to local supply voltage, the Evolution™ RC is designed to accommodate a broad range of electrical configurations — from 187–253 volts — and can handle extreme variations in supply voltage without operation or performance capabilities being affected.

Diagnostics

In the event of a warning condition or system malfunction, the centrifuge displays a message identifying the source of the problem. Fault conditions are verified before they are reported on the display, eliminating “nuisance” faults that could be generated by normal system operation. In addition, Kendro service representatives can access more detailed information to expedite diagnosis and troubleshooting of fault conditions.

A toll free number is available in the United States for technical assistance, 800-522-7746. Elsewhere, contact the nearest Kendro office (see back cover) or your local SORVALL® products representative.

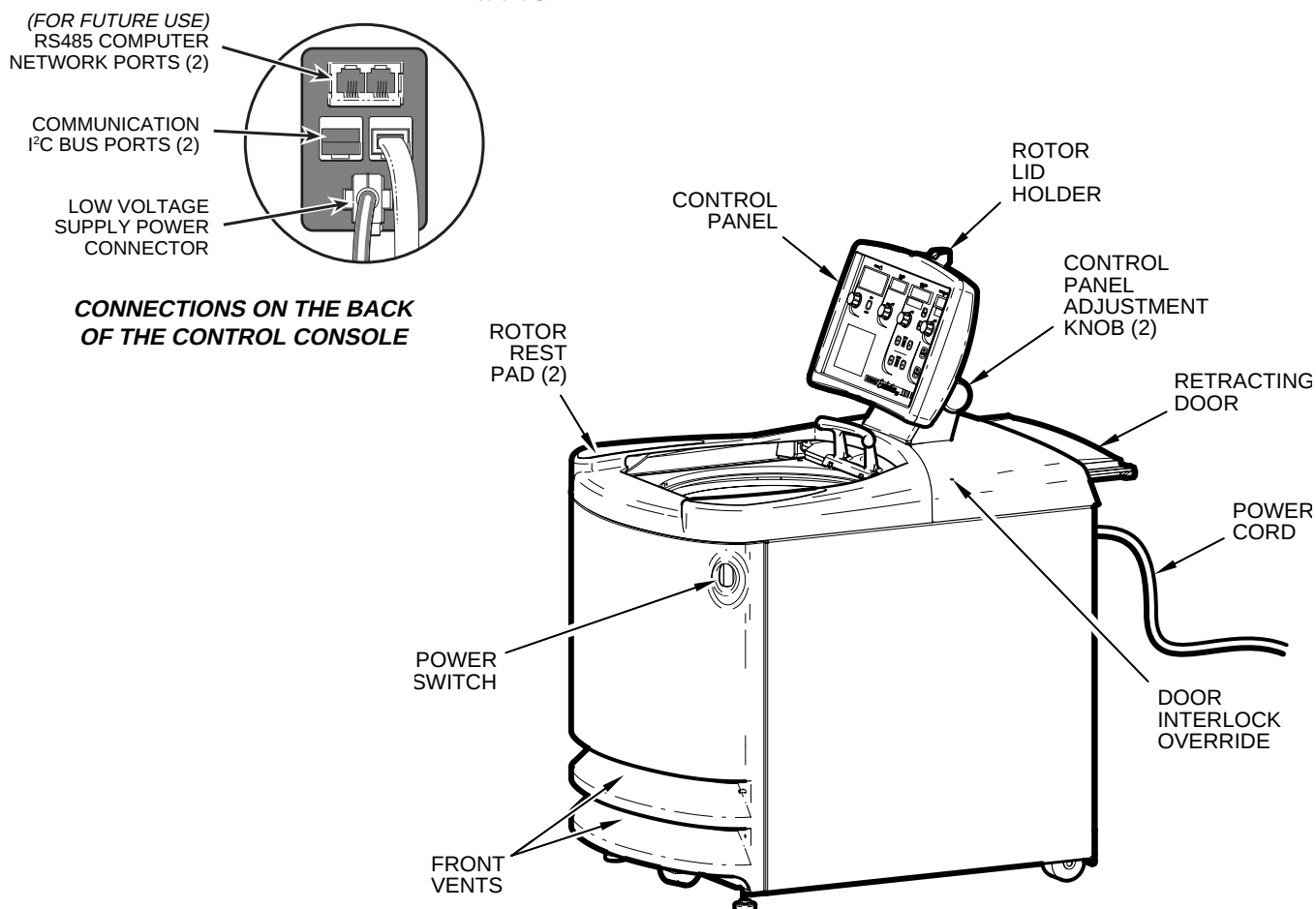


Figure 1-1. Evolution™ RC Parts Location and Identification

Centrifuge Specifications

Rotor Speed

Set Speed Range 100 (rpm or RCF) to rotor maximum; in increments of 10 below 1000, and in increments of 100 above 1000 (calculates to single digits in rpm/RCF mode change)

Speed Control $\pm 0.2\%$ or 20 rpm, whichever is greater

Maximum Speed 26 000 rpm (with SE-12 rotor)

Maximum RCF 70 450 *g* (with SE-12 rotor)

Temperature

Set Range -20°C to $+40^{\circ}\text{C}$ in 1°C increments

Temperature Control $\pm 2^{\circ}\text{C}^1$

Control Range $+2^{\circ}\text{C}$ to $+40^{\circ}\text{C}$

Temperature Displayed Estimated sample temperature in 1°C increments

Time

Set Time Range One minute to 99 hours, 59 minutes; or select HOLD for continuous operation

Time Displayed Indicates time remaining (timed run) or time elapsed (continuous/hold run) up to 99 hours, 59 minutes

Environment Conditions

Ambient Temperature 10°C to 38°C (50°F to 100°F)¹

Relative Humidity Up to 90%, non-condensing

Noise Level 63 dbA²

Dimensions

Width 710 mm (28.0 inches)

Height 1295 mm (51.0 inches) to top of control console;
850 mm (33.5 inches) to top deck lift-over

Depth 1055 mm (41.5 inches) with door closed;
1125 mm (44.2 inches) with door open

Net Mass (weight) 390 kg (860 lb)

Electrical Requirements

60 Hz, single phase, 30 A 208-230Vac $\pm 10\%$ (187–253V)

50 Hz, single phase, 32 A (CE certified) 208-230Vac $\pm 10\%$ (187–253V)

50/60 Hz polyphase, 32 A (CE certified) 208-230Vac $\pm 10\%$ (187–253V)

Approved configurations and power cord for the above:

- 60 Hz, single phase: NEMA receptacle 6-30R for NEMA plug 6-30P
- 50 Hz, single phase: IEC 60309 receptacle for 3-pin plug
- 50/60 Hz polyphase: IEC 60309 receptacle for 5-pin plug

¹ The centrifuge will operate in ambient temperatures ranging from $+10^{\circ}\text{C}$ to $+38^{\circ}\text{C}$ (50°F to 100°F); temperature control specifications may not be maintained for high speed, low temperature runs if inlet air temperature is above 25°C (77°F).

² With an SS-34 rotor at 20 500 rpm and 4°C , measured 3 feet from the front panel at an approximated operator height.

Chapter 2: Installation

This chapter contains instructions on preparing your SORVALL® Evolution™ RC centrifuge for operation. Initial installation is to be performed by your local Kendro Service representative.

Inspection

When you receive your centrifuge, carefully inspect it for any signs of shipping damage. If you find damage, please report it immediately to the transportation company and file a damage claim, then notify Kendro. Also check the parts received with the centrifuge against the shipping list; if any parts are missing, contact Kendro (see back cover).

Location

Locate the Evolution™ RC on a level floor and allow space for the size of the centrifuge (figure 2-1), plus clearance for door travel, free air circulation, and safe operation.



WARNING

The Evolution™ RC weighs 390 kg (860 lbs). Be careful when moving and installing the centrifuge. Failure to use proper techniques can result in personal injury and/or damage to the centrifuge.



CAUTION

Do not move the centrifuge using the chamber door handle or the control console, or damage to these parts could result.

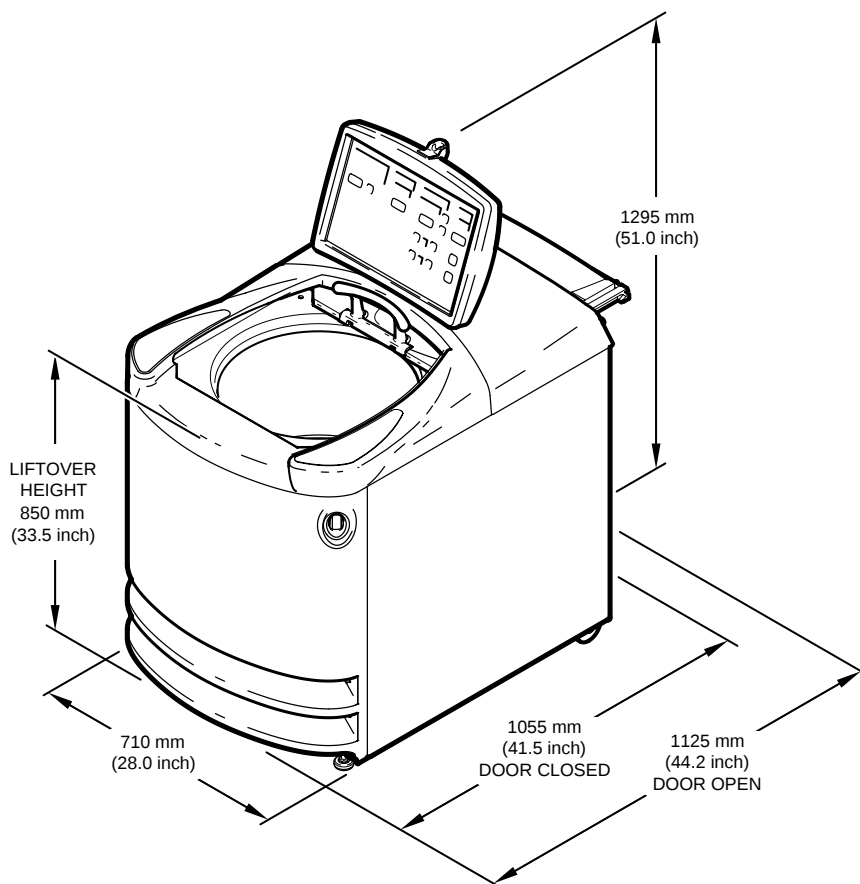


Figure 2-1. Centrifuge Dimensions

For free air circulation, required to achieve specified temperature control and allow for proper component cooling, the centrifuge requires a minimum of 140 mm (5-1/2 inches) clearance behind the rear panel.

For safety, personnel should know that centrifuges routinely deal with high energy levels and could move suddenly in the unlikely event of a rotor failure. Laboratory management procedures should require that no person or any hazardous materials are within a “clearance envelope” boundary of 300 mm (12 inches) from the centrifuge while it is operating. During centrifuge operation, personnel should be instructed not to lean on or move the centrifuge, not to stay within the clearance envelope longer than necessary for operational reasons, and not to deposit potentially hazardous materials within the clearance envelope.

Environmental Conditions

An ambient temperature range of 10°C to 38°C (50°F to 100°F) must be maintained for centrifuge operation. The relative humidity can be up to 90%, non-condensing. For optimal temperature control at low set temperatures, ambient temperature should not exceed 25°C (77°F). If the ambient temperature exceeds 25°C, the centrifuge may not maintain low temperatures at high speeds for some rotors.

The centrifuge is intended for use in 1) a Pollution Degree 2 Environment, 2) an installation category II supply circuit, and 3) at a maximum altitude of 2000 meters.

Electrical



CAUTION

The Evolution™ RC can be damaged if connected to a voltage for which it has not been manufactured or configured. If the centrifuge must be moved from its original installation location to a different supply source, an electrician should compare the supply voltage to the rating plate information on the back of the centrifuge to confirm compatibility before connecting to power. After connection, loaded line voltage should be measured during full acceleration. If power source is not compatible, or if compatibility or centrifuge configuration is at all questionable, contact Kendro Service.

The Evolution™ RC will operate safely and meet the performance specifications detailed in Chapter 1 at the following voltage ranges:

Phase	Hz	Amps	Voltage Range
Single	60	30	208–230 ±10% (187–253)
Single	50	32	208–230 ±10% (187–253)
Poly	50/60	32 each	208–230 ±10% (187–253)

The Evolution™ RC has been designed to ensure full performance under the broadest possible range of voltage conditions. During initial installation by your local Kendro Service representative, the centrifuge input wiring may require reconfiguring, based on the nominal local supply voltage as well as on the loaded line voltage measured at the installation site. Even with this fine-tuning adjustment, however, if voltage at the installation site falls outside of the specified range, you may notice variations in centrifuge performance or experience reduced performance.

60 Hz single-phase centrifuges are supplied with a 3-wire power cord with 3-prong plug, including ground connection, to fit a NEMA 6-30R receptacle. 50 Hz single-phase centrifuges are CE-rated and are supplied with a 3-wire power cord for an IEC 60309-type 3-pin receptacle (32A, 2-pole and earth). 50/60 Hz polyphase centrifuges are also CE-rated, and are supplied with a power cord for a IEC 60309-type 5-pin receptacle (32 A, 3-pole, neutral and earth).

The ON/OFF main power switch is a 30-Amp circuit breaker; however, we recommend a separate means of power interruption in a remote location for emergency disconnect purposes.

Levelling



CAUTION

The centrifuge can be seriously damaged if it is operated when it has not been properly levelled.



WARNING

The front stabilizers must be used as explained in this section to lift the caster off the floor. This will help minimize centrifuge movement in the event of a rotor failure.

1. Position the centrifuge in its operating location.
2. Using the 3/4-inch (19 mm) wrench supplied, lower the two front locking stabilizers until they lightly contact the floor.
3. Rotate each stabilizer an additional four revolutions until the front caster in the center is about 5 mm (3/16 inch) off the floor and spins freely.
4. Check that the centrifuge does not rock on its four support points, the two front stabilizers and the two rear casters (see figure 2-2).

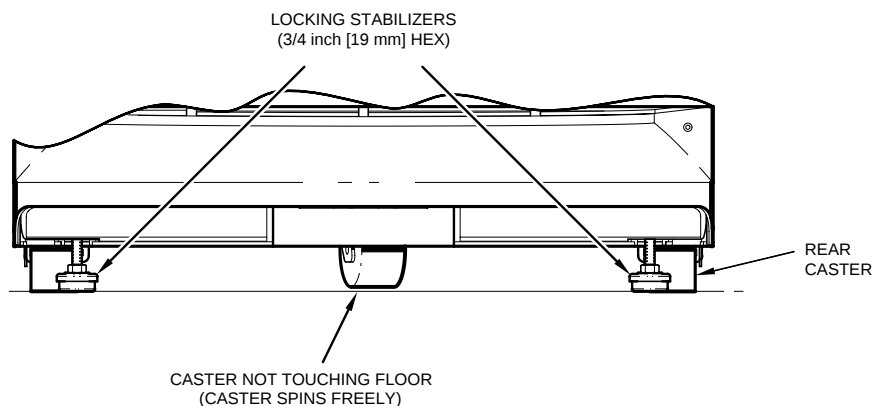


Figure 2-2. Leveling Adjustment

Setting Up the Control Panel

To adjust the angle of the control panel:

1. Loosen the two knobs located just behind the control panel on either side of the base (see figure 2-3 on the next page).

NOTE Both knobs are loosened by turning them counterclockwise. However, because the two knobs face in opposite directions, when loosened and tightened from in front of the centrifuge, they will turn in opposite directions.

2. Tilt the control panel to the desired angle.
3. Tighten the knobs into place.

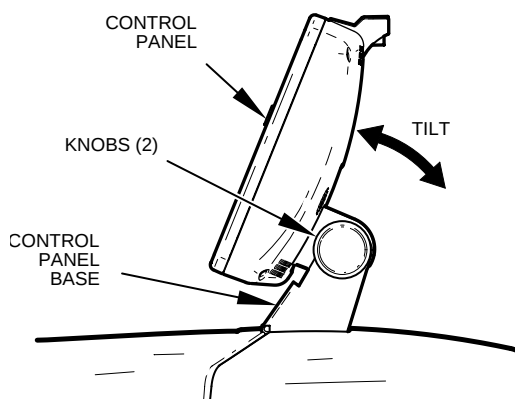


Figure 2-3. Control Panel Adjustment

Chapter 3: CONTROLS

This chapter provides a detailed description of the Evolution™ RC controls. For step-by-step operating instructions, see Chapter 4, Operation.

Control Panel

NOTE: To adjust the angle of the control panel:

1. Loosen the two knobs on either side of the base of the control panel (see figure 2-3). The knobs turn in opposite directions.
2. Tilt the control panel to the desired angle.
3. Tighten the knobs firmly into place.

The control panel for the Evolution™ RC may be purchased with either knobs or up and down arrow keys — referred to as “scroll keys” — for setting run parameters. Figure 3-1 on the next page shows the two control panel models available. Although the mechanical means for setting the run parameters differ, the displays and functions are identical for both panels.

Functional Areas

The control panel consists of five major functional areas:

1. Rotor/Message
2. Time
3. Speed
4. Temperature
5. Start/Stop Controls.

The top line of the Rotor/Message area identifies the rotor; the bottom line either identifies the rotor type or displays informational/error messages. The Time, Speed and Temperature areas have two separate displays: the bottom display shows the set parameters; the top display shows the actual run conditions.

Setting Run Parameters

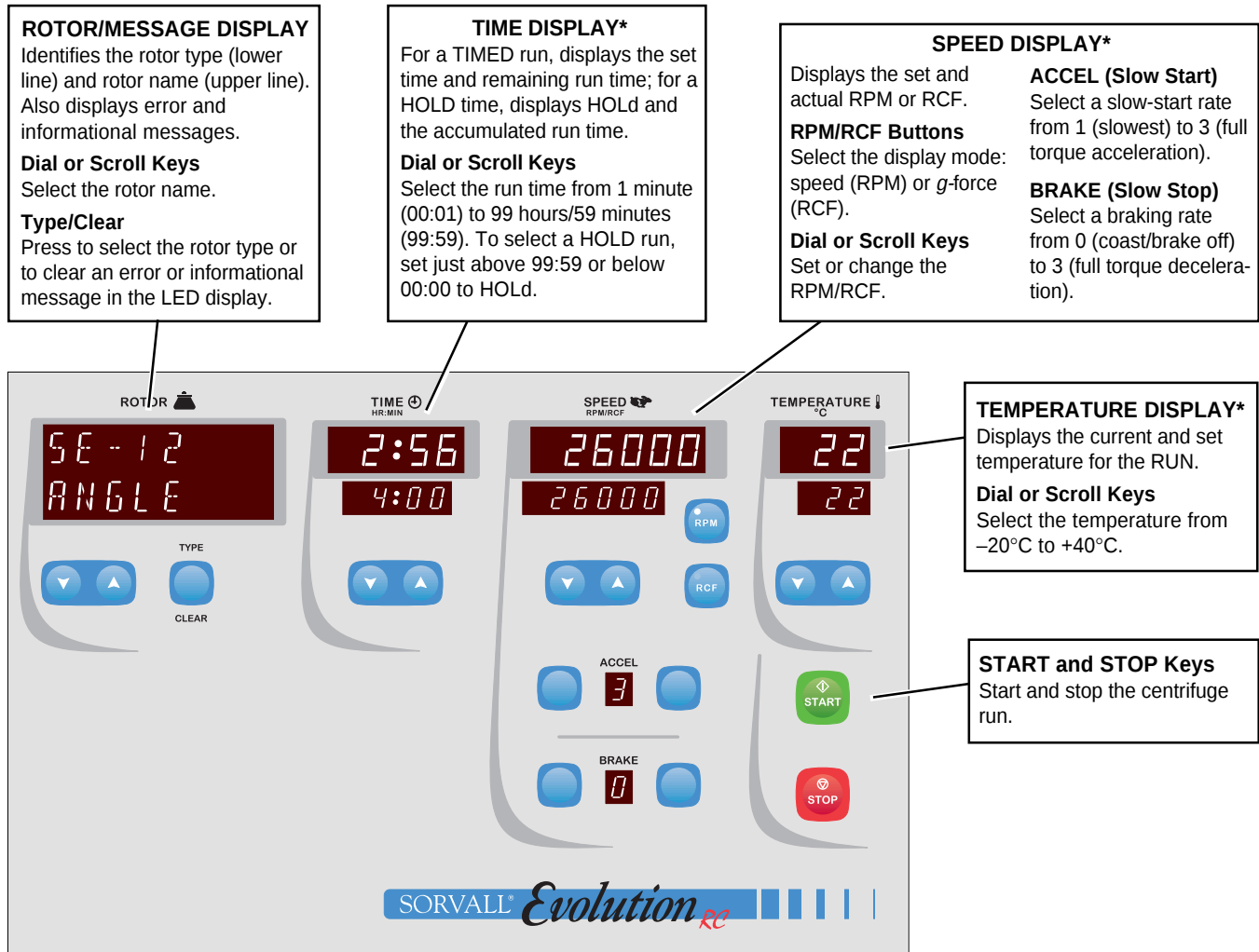
The means for setting the run parameters depends upon the centrifuge control panel.

Control Panel with Knobs

Turn the knob beneath the appropriate display to the right or left until the desired setting is shown. The display values increase or decrease at different increments according to the speed with which you turn the knob: the faster you turn the knob, the larger the increment.

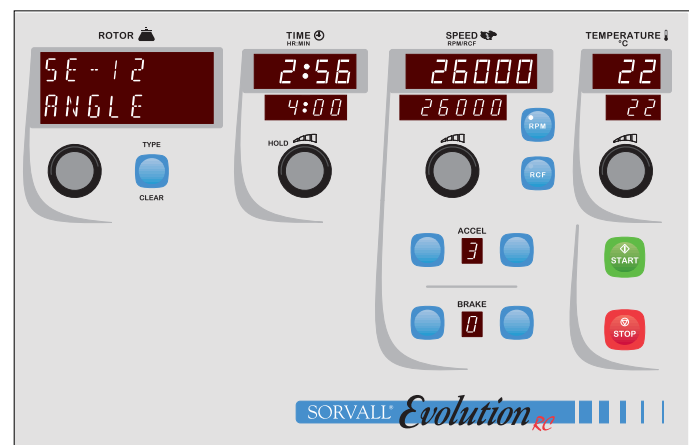
Control Panel with Scroll Keys

Press the up or down scroll key until the desired setting is shown. The display values increase or decrease at different increments according to the length of time you hold down the scroll key. A single press of the key advances the smallest increment; the longer you hold the key down, the larger the increment.



Control Panel with Scroll Keys

* Upper display = Actual run condition
Lower display = Set parameter



Control Panel with Knobs

Figure 3-1. Control Panel



Rotor Display and Controls

This portion of the control panel serves two functions:

1. Identifies the name and type of the rotor selected for a run.
2. Shows error and informational messages on the bottom line of the display.

Rotor LED Display

The rotor name is identified on the top line of the LED display and the rotor type is identified on the bottom line.

When a fault occurs or when information needs to be relayed to the user due to certain run conditions, the rotor type is replaced with a descriptive message. The message scrolls continuously across the display until it is cleared (see TYPE/CLEAR Key below). Messages and their corresponding corrective actions are itemized in *Chapter 6, Error and Informational Messages*.

TYPE/CLEAR Key

This key serves two functions: 1) to select the rotor type, and 2) to clear error and informational messages that appear in the LED display. Either TYPE or CLEAR is illuminated at any given time to indicate which function is currently active.

TYPE Function

When TYPE is illuminated, the rotor type is shown on the bottom line of the Rotor LED display. The TYPE key is used to scroll through the rotor types. Selections include the following:

Type	Description
RECENT	The five most recent sets of unique run parameters in last-in, first-out order (the most recent run is shown first). A run is considered unique if one or more run parameters are different. For instance, two sets of run parameters that are identical with the exception of the rate of acceleration are considered unique.
ANGLE	Fixed angle rotors
SWINGING	Swinging bucket rotors
OTHER	All other rotors (vertical, continuous flow, etc.)

NOTE: You can optionally use the Rotor Dial/Scroll Keys to scroll continuously through all rotors and rotor types.

To scroll through the rotor types, you may press the TYPE key repeatedly or hold the key down until the desired type is shown.

CLEAR Function

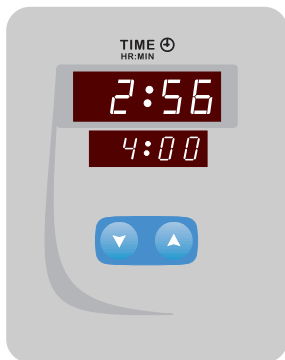
CLEAR is illuminated when an error or informational message appears on the lower line of the LED Display. The CLEAR key is used to clear the message and redisplay the rotor type. For detailed information on error handling, refer to *Chapter 6, Error and Informational Messages*.

Rotor Knob/Scroll Keys

The rotor knob / scroll keys are used to select a specific rotor within a rotor type. Turn the rotor knob to the right or left or press the up / down scroll keys until the desired rotor is shown. Here are guidelines for making a selection:

- Rotors are displayed on the upper line of the LED display, rotor types are identified on the bottom line. Rotors are displayed in the same order that they appear in the Rotor Information table in the Appendix (page A-2).
- As you move through the rotor list, the display advances from one rotor type to the next — from RECENT to ANGLE, SWINGING, OTHER and vice versa.
- When you reach the end of the rotor list, the display wraps around to the beginning of the list (in either direction).
- The TYPE key is optional when selecting a rotor. You can use it at any time to quickly advance to a specific rotor type.

NOTE: The rotor name cannot be changed while a run is in progress.



Time Display and Controls

Time LED Display

The Time LED display shows the following:

- Upper display — Actual run time once a run is in progress
- Lower display — Time setting selected.

You may select a timed run or a continuous “hold” run.

Time Knob/Scroll Keys

The time knob / scroll keys are used to set the centrifugation run time. The SET display values increase or decrease incrementally according to the speed with which you turn the knob or the length of time you hold down the scroll key.

Timed Run

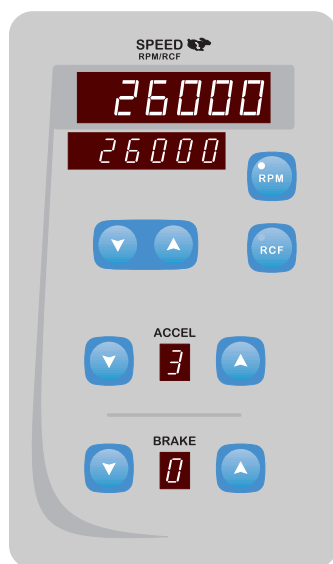
Timed runs may range from one minute (00:01) to 99 hours and 59 minutes (99:59). The HR:MIN value you select appears in the SET display. When you press START, the timer begins and the RUN display counts down from the set value to zero (00:00), then shows END.

You can change the time or switch to a HOLD run while the run is in progress.

HOLD Run

To select a HOLD run, turn the time knob / scroll keys one setting lower than 00:01 or above 99:59. HOLD appears in the SET display. The RUN display counts up from 00:00, showing the accumulating run time until you press the STOP key. After 99:59, HOLD appears in the RUN display until you stop the run.

You can switch to a timed run at any time.



Speed Display and Controls

RPM/RCF Keys

Press the appropriate key to select RPM or RCF (*g*-force). The indicator on the key illuminates, verifying the mode selected. You may press the RPM or RCF key at any time during a run to switch the display between RPM and *g*-force.

Speed LED Display

The Speed LED display shows the following:

- Upper display — Run speed / *g*-force once a run is in progress.
- Lower display — Set speed / *g*-force.

You cannot set the speed higher than the maximum allowed for the rotor indicated in the Rotor / Message Display.

NOTE: If you specify a speed and then select a rotor, the speed will default to the maximum allowed for the rotor. Always select a rotor before specifying a speed.

Speed Knob/Scroll Keys

The speed knob / scroll keys are used to select the centrifugation RPM or RCF. The SET display values increase or decrease incrementally according on the speed with which you turn the knob or the length of time you hold down the scroll key.

The maximum RPM / RCF allowed depends on the rotor specified on the Rotor / Message Display.

ACCEL

ACCEL is used to specify the acceleration time. Two slow-start options are designed to provide optimal reorientation conditions and prevent disturbance of gradient or pellet. A full-torque acceleration option is also available. Options include:

Option	Acceleration Time
1 (Slow)	2 minutes (approximate) to 500 rpm
2 (Medium)	1 minute (approximate) to 500 rpm
3 (Fast)	Full torque acceleration

When a slow-start option is selected, the rotor accelerates from 0–500 rpm over a predefined time period, then accelerates at full torque to set speed. When you press START, the ACCEL selection blinks during the slow-start period. You cannot change the ACCEL selection once a run has started.

BRAKE

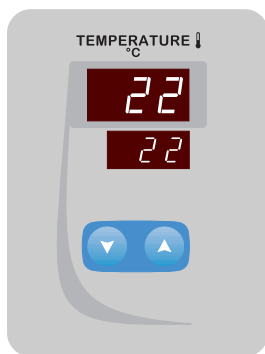
BRAKE is used to specify the deceleration time. The following options are available:

Options	Deceleration Time
0 (Slow)	Coast (brake off)
1 (Medium slow)	2 minutes (approximate) from 500–0 rpm
2 (Medium fast)	1 minute (approximate) from 500–0 rpm
3 (Fast)	Full torque deceleration

Options 0–2 are slow-stop options, and are designed to provide optimal reorientation conditions and prevent disturbance of gradient or pellet:

- For option 0, the rotor decelerates from set speed to a complete stop without any braking action. The BRAKE selection blinks from 500–0 rpm.
- For options 1 and 2, the rotor decelerates from 500–0 rpm over the period of time indicated. When the slow-stop time threshold is reached, the BRAKE selection blinks until 0 speed is reached.

You may select a BRAKE option at any time during a run except when deceleration below 500 rpm is in progress.



Temperature Display and Controls

Temperature LED Display

The Temperature LED display shows the following:

- Upper display — Calculated sample temperature
- Lower display — Set sample temperature

Temperature Knob/Scroll Keys

The temperature knob/scroll keys are used to select the centrifugation temperature. Temperature can range from –20°C to +40°C. The temperature field defaults to the setting for the previous run. You may change the temperature setting at any time during a run.

The SET display values increase or decrease incrementally depending on the speed with which you turn the knob or the length of time you hold down the scroll key.



Start and Stop

The START and STOP keys are used to start and stop a run, respectively.

Start Key

Once all run parameters have been entered, the START key is pressed to begin a run. The rotor will accelerate at the rate specified in the ACCEL field.

NOTE: In order for the run to start, a rotor, run time and run speed must be specified and serious error conditions must be corrected and the corresponding message(s) cleared from the Rotor/Message Display.

Stop Key

The STOP key may be pressed at any time to end a run. The run will decelerate at the rate specified in the BRAKE field. When the Rotor/Message Display reads End and a beep sounds, you can safely open the rotor chamber door.

Chapter 4: Operation

This chapter provides step-by-step instructions for operating the Evolution™ RC Centrifuge.

Startup Procedure

Step 1 – Power On the Centrifuge

Turn the centrifuge power ON using the power ON/OFF switch on the upper right corner of the front cabinet panel. The microprocessor automatically runs a system test every time the centrifuge is turned on. During the system test routine, “PLEASE WAIT” will appear in the Rotor/Message Display; do not attempt to open the chamber door or to use any controls until after the test routine is completed.

- If an error is found in the system test, you are notified with a message in the Rotor/Message Display.
- After the system test, the Rotor field defaults to “-----,” indicating that a rotor needs to be identified. All settings in the remaining displays (time, speed and temperature) are those for the most recent run.

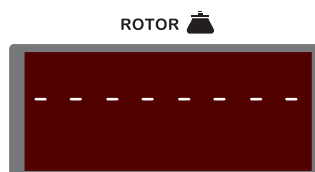


Figure 4-1. Rotor Message Display at Startup

To ensure that the rotor and chamber temperatures are at equilibrium at the start of the run, you may optionally follow the precool/preheat procedure on page 4-4.

Step 2 – Load and Identify the Rotor

For best run conditions and prolonged centrifuge life, the rotor chamber should be dry at the start of a run. Before installing the rotor, wipe the chamber dry with a clean cloth or paper towel.

Tips for Preparing Rotors and Tubes

When preparing and loading rotors and tubes, you can use the following features of the Evolution™ RC:

1. Rest the rotor cover (if any) on top of the control panel: Slide the rotor locking screw into the rotor lid holder located at the center top of the control panel.
2. Rest the rotor/tubes on the rubberized panels on either side of the door.



WARNING

Be sure the rotor and/or tubes are properly supported when resting them on the rubberized side panels. Improperly supported parts can tip and cause equipment damage and personal injury.



WARNING

When loading the rotor, be sure not to exceed the maximum compartment mass of the rotor (see the Rotor Information Table in the Appendix). If the maximum compartment mass is exceeded, the maximum operating speed must be reduced (see Reducing Speed for Rotor Compartment Loads in Excess of Design Mass in this chapter). Failure to do so can cause rotor failure which could result in personal injury and/or centrifuge damage.

Do not operate the centrifuge without the rotor properly installed. The rotor cover must be secured to the rotor and the rotor must be properly seated and locked to the centrifuge drive spindle. See the rotor manual.



WARNING

Before performing a run, be sure that the rotor displayed on the control panel is the installed rotor. Use only approved SORVALL® rotors (refer to Rotor Information in the Appendix). Installing an unapproved rotor or misidentifying a rotor, depending on the rotor/speed combination set, may allow operation at speeds above the maximum rated speed of the installed rotor, possibly resulting in rotor failure.

Loading and Identifying the Rotor

1. Prepare the rotor:

- Load and balance the samples. The Evolution™ RC has a greater imbalance tolerance than other centrifuges, because the imbalance margin is defined uniquely for each rotor.
- Place the cover (if any) on the rotor.
- For fixed-angle rotors, turn the large cover locking knob counterclockwise to secure the cover to the rotor.

For further details, refer to the rotor manual.

2. Open the chamber door. When you press against the handle, it slides open.

Tip: The door handle is designed for easy opening while you are holding a rotor. Press the rotor body against the handle to slide the door open.

3. Install a rotor approved for use in the Evolution™ RC, making sure the rotor is fully seated and does not rock on the tapered spindle, then lock the rotor to the drive spindle by turning the small rotor locking knob counterclockwise.

4. Note name of the installed rotor, then close the chamber door.

5. Select the rotor type and rotor –it is important to correctly specify the installed rotor; *read the WARNING*:

- To recall the most recently used rotor, either press the TYPE key once or, depending on the control panel installed, press a rotor scroll key once or turn the rotor knob a single notch.
- To select any other rotor, use the rotor knob / scroll keys. Rotors are listed in the order indicated on the rotor table on page A-2. You can press the TYPE key at any time to move directly to a specific rotor type.

Rotor types include:

Type	Rotor Description
Recent 1–5	The last five different rotors used in last-in, first-out order (the most recently used rotor = RECENT 1). When you select a rotor from this category, the set parameters (time, speed, temperature, etc.) default to the most recent parameters used with the rotor.
Angle	Fixed angle
Swinging	Swinging bucket
Other	All other rotors (vertical, continuous flow, etc.)

NOTE: Unless RECENT is chosen to recall parameters, when a rotor is selected, the SPEED setting will default to that rotor's maximum.

6. To use the default run parameters shown on the control panel, simply press the START key to begin centrifugation. To change any of the parameters, refer to the steps that follow.

Step 3 – Set the Time Parameters

You can select a timed run or a continuous (hold) run. The timed run counts down (in hours and minutes) from the time you set to 00:00, then comes to a stop automatically. The continuous (hold) run counts up from zero (00:00) and continues until you press the STOP key.

- **For a Timed Run**

Specify the desired time in the SET display. Time may range from 1 minute (00:01) to 99 hours and 59 minutes (99:59).

- **For a Continuous (Hold) Run**

Advance the TIME controls (knob or scroll keys) above 99:59 or below 00:01 until HOLD appears in the SET display.

Step 4 – Set the Speed Parameters (RPM/RCF)

Speed may be set in either RPM or RCF (g-force). Use the RCF option when you know the g-force to be applied during centrifugation. The corresponding RPM is automatically calculated.

NOTE: Specify the installed rotor before setting desired run speed. Otherwise, when the rotor is selected, the set speed will automatically change –either to a value from a recent run, or to the displayed rotor's maximum.

1. Press the RPM or RCF button to indicate the mode for setting the run speed. The light on the corresponding button illuminates.
2. Set the desired run speed (in terms of the selected mode, either RPM or RCF) using the knob or scroll keys.
3. Set the acceleration time to one of the following:

Entry	Acceleration Time (approximate)
1 (Slow)	2 minutes from 0 to 500 rpm
2 (Medium)	1 minute from 0 to 500 rpm
3 (Fast)	Full torque acceleration

Options 1 and 2 are slow-start options. When selected, the rotor accelerates from 0 to 500 rpm over the time period indicated above, then accelerates normally to set speed.

4. Set the braking time to one of the following:

Entry	Deceleration Time (approximate)
0 (Slow)	Coast (brake off)
1 (Medium slow)	2 minutes from 500 to 0 rpm
2 (Medium fast)	1 minute from 500 to 0 rpm
3 (Fast)	Full torque deceleration

Options 0, 1 and 2 are slow-stop options. When selected, the rotor decelerates from 500 to 0 rpm over the time period indicated above.

Step 5 – Set the Temperature (°C)

Temperature settings can be from –20°C to +40°C; the control range for estimated sample temperature is from +2°C to +40°C. To change the temperature setting, use the temperature knob or scroll keys.

NOTE: To achieve a large change in rotor and chamber temperature in a short length of time, we recommend pre-equilibrating rotor and chamber temperature (see Rotor Precool/Preheat below) to avoid the possibility of a ROTOR OVER TEMP or ROTOR UNDER TEMP fault.

If performing maximum speed runs in ambient temperature conditions above 25°C (77°F), the system may be unable to maintain extremely low sample temperature with some rotors.

Step 6 – Start the Run

Press the START key to start the run (*read the WARNING*).



WARNING

Do not leave rotors or other objects on centrifuge surfaces during operation.

Also during centrifuge operation, do not stay within a “clearance envelope” boundary of 300 mm (12 inches) from the centrifuge longer than necessary for operational reasons, do not lean on or move the centrifuge, and not to deposit potentially hazardous materials within the clearance envelope.

In order for the run to start, a rotor, run time and run speed must be specified; the rotor chamber door must be closed; and any serious error conditions must be corrected and the corresponding message(s) cleared from the Rotor/Message Display. If these conditions are not met, correct the condition(s) in error and press START again.

Rotor Precool/Preheat (Optional)

You may precool or preheat the rotor and rotor chamber, if necessary, to ensure that the rotor and chamber temperatures are at equilibrium at the start of a run. To do so:

1. Open the chamber door and install the rotor.
2. Close the chamber door, then specify the installed rotor.
3. Set the TIME display to HOLD.
4. If precooling, set speed to 2500 rpm; if preheating, set speed to approximately 90% of the rotor maximum.
5. Set the desired temperature, then press START.
6. Allow the centrifuge to run until the value in the upper temperature display is within two degrees of the value in the lower temperature display, then press STOP.

In many cases, the temperature will come into range within five minutes; the actual time required to preequilibrate temperatures will vary by rotor and other factors.

NOTE: Composite rotors require significantly more time to change temperature than metallic rotors. Therefore, rather than attempting to equilibrate a composite rotor in the centrifuge, we recommend storing composite rotors in a temperature-controlled environment to ensure desired sample temperature.

Once a Run is in Progress

Slow-Start/Slow-Stop

If you selected a slow-start option, the entry in the ACCEL field blinks until full torque acceleration begins. If you selected a slow-stop option, the BRAKE selection blinks during deceleration until 0 speed is reached.

Changing the Run Parameters

While a run is in progress, you can change all run parameters at any time with the following exceptions:

- The acceleration selection cannot be changed during acceleration.
- The brake selection cannot be changed while the rotor is decelerating below 500 rpm.
- Rotor and rotor type cannot be changed until the rotor has come to a stop and End is shown in the SPEED Display.

You can switch the display between RCF and RPM at any time by pressing the RPM/RCF key. You can also switch between a timed run and a continuous (hold) run.

Switching to a Timed Run

To switch to a timed run while a hold run is in progress, enter the remaining run time desired in the SET Display. The RUN display counts down from the time you specify.

Switching to a Hold Run

If you switch to a hold run while a timed run is in progress, the RUN display begins counting up from the run time which has already elapsed.

For example, suppose you are 15 minutes into a one hour timed run. When you switch to HOLD, the RUN display begins counting up from 00:15 and continues until you press STOP.

Stopping the Run

Timed runs come to a stop once the set time has counted down to 00:00. You can press the STOP key at any time to stop a timed run before the set time has elapsed. The run stops according to the brake option selected on the control panel. The remaining run time is displayed in the Time RUN Display.

To stop a continuous (hold) run, you must press the STOP key. The accumulated run time is displayed in the Time RUN Display.

When the run has come to a stop, End appears on the Speed Display and a long beep sounds. The rotor chamber door unlocks and is safe to open.

If a Power Outage Occurs

If a power outage occurs, the Evolution™ RC automatically restarts once the power returns. If a run was in progress at the time of the outage, the interrupted run will resume, providing the run speed remains above 1000 rpm and no faults have occurred. The message Power Resumed appears in the Rotor/Message Display.

If the run speed is less than 1000 rpm when the power returns, the rotor coasts or brakes to a stop and the centrifuge goes into standby mode. The message POWER FAILURE appears in the Rotor/Message Display, notifying you that the power was interrupted.

Reducing Speed for Rotor Compartment Loads in Excess of Design Mass



WARNING

Failure to properly reduce set speed when rotor compartment loads exceed the rotor's maximum allowable compartment mass can result in rotor failure.

There is a maximum allowable compartment mass established for each centrifuge rotor (see Rotor Information in the Appendix). To prevent rotor failure, the total contents of any compartment, including specimen, tubes, cover, and adapters (if used) must not exceed the mass specified unless rotor speed is reduced proportionally.

Strict adherence to the maximum allowable compartment mass or reduced speed is required to prevent rotor failure. Read the WARNING on the Safety Information Page in front of this manual.

The rotor speed is reduced in proportion to the square root of the ratio for the maximum allowable compartment mass to the actual compartment mass (including specimen, tubes, covers, and adapters). If the compartment mass is more than that specified for the rotor, the reduced speed can be determined by using the formula given below.

$$\text{Reduced Speed} = \text{Maximum Rotor Speed} \times \sqrt{\frac{\text{Maximum Compartment Mass}}{\text{Actual Compartment Mass}}}$$

Energy Management System

The Evolution™ RC's Energy Management System is designed to ensure that the energy produced by the rotor/load/speed combination will not exceed the maximum allowable for the centrifuge to safely contain a rotor failure.

During acceleration, the Energy Management System evaluates the performance of the installed rotor to establish how much energy would be produced if the run was to continue to SET speed. If it is determined that the energy produced could exceed the maximum allowable, the run will be terminated and an ENERGY EXCEEDED message will be displayed in the ROTOR field.

Do not expect the Energy Management System to reduce set speed, or to determine if a rotor has been misidentified or overloaded in such a way that the set speed is too high. To prevent rotor failure, be sure to correctly specify the installed rotor, and if compartment loads exceed design mass, always reduce maximum speed according to the square root formula on the previous page.

NOTE If, for some reason, the Energy Management System is unable to determine how much energy would be produced, motor torque will be reduced and SPEED LIMITED RUN will be displayed in the ROTOR field. When motor torque is reduced, it takes longer to accelerate to set speed and, in a few cases, the maximum attainable speed could be reduced slightly (limited by windage).

Continuous Flow Operation

If you are using the TZ-28/GK or SS-34/KSB rotor for continuous flow operations, you may need to purchase the kits described below.

NOTE: You can use the TZ-28 rotor in the Evolution™ RC for sealed or continuous flow runs only. Dynamic loading is not available.

TZ-28/GK Rotor

The following kits are used for TZ-28/GK continuous flow operation in the Evolution™ RC:

Catalog #	Description
49633	Continuous Flow Distributor Adapter for Inlet-Outlet Assembly
49089	Inlet-Outlet Assembly for Distributor Adapter

If you have previously purchased the kits required, you can use them in the Evolution™ RC. If necessary, to obtain a tubing holder for an Evolution™ RC (see figure 4-2), contact Kendro.

SS-34/KSB

The KSB-R Continuous Flow System Kit (Catalog No. 14005) is required to operate an SS-34/KSB System in the Evolution™ RC. If you have previously purchased this kit, you can use it in the Evolution™ RC. If necessary, to obtain a tubing holder for an Evolution™ RC (see figure 4-2), contact Kendro.

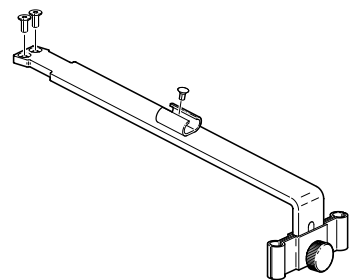


Figure 4-2. Evolution™ RC Tubing Holder

Chapter 5: MAINTENANCE

This chapter describes routine maintenance procedures that are to be performed by the user. Any further maintenance should be performed by a Kendro Service Representative or other qualified service personnel.



WARNING

There are no user-serviceable items inside the centrifuge. High voltage electrical circuits in this centrifuge can cause severe electrical shock. Due to the hazards involved, repair should only be attempted by a qualified technician who is familiar with electronics and trained in the servicing of this centrifuge; untrained personnel must not attempt procedures that are not included in this manual. Failure to comply can result in personal injury.

If hazardous materials have been processed in the centrifuge, take all necessary precautions when cleaning or servicing the centrifuge to avoid personal exposure to contaminants.



CAUTION

Use only cleaning and decontamination methods mentioned in this guide or in the SORVALL® Product Guide. Cleansers other than those specified may be harmful to the centrifuge.

To gain the most in safety, performance, and useful life from your centrifuge, it is necessary to maintain it as described in this chapter. Proper maintenance is a simple and inexpensive way to help prevent major failures. In addition to the maintenance described in this chapter, a Kendro service contract, which includes a yearly Preventive Maintenance visit, is recommended to keep your centrifuge in good condition.

Table 5-1 is a suggested maintenance schedule.

Table 5-1. Maintenance Schedule

Clean...	Frequency
Rotor chamber	Daily or immediately after a spill
Tapered spindle	Wipe before installing a rotor, clean once a week
Cabinet panels	Once a month
Control panel	Once a month
Door seal	Once a month
Front vents	Check monthly; clean as required

**WARNING**

Because of the characteristics of the samples likely to be processed in this centrifuge, biological or radioactive contamination may occur. Always be aware of this possibility, and take normal precautions. Use appropriate decontamination procedures should exposure occur.

**CAUTION**

Chlorides are extremely harmful to aluminum alloy rotors and can cause stress corrosion cracking. Therefore, do not use chlorides to disinfect the chamber.

Cleaning

Rotor Chamber

The rotor chamber should be kept clean and wiped dry routinely to maintain efficient cooling. Wash the chamber with a mild, *nonalkaline* detergent (such as dishwashing liquid) and warm water, then rinse and dry with a soft absorbent cloth.

Use 70% ethanol to disinfect the rotor chamber or a 2% glutaraldehyde solution to sterilize it. For general radioactive decontamination, use a solution of equal parts of ethanol, 10% SDS, and water. Follow this with ethanol rinses then deionized water rinses. Dry with a soft absorbent cloth. Dispose of all wash solutions in proper radioactive waste containers.

Drive Spindle

Wipe the drive spindle with a soft cloth each time a rotor is to be installed to reduce the chance of the rotor sticking. Once a week, wipe the drive spindle with a cloth dampened with warm water.

Cabinet

Use a mild *nonalkaline* detergent (such as dishwashing liquid) and warm water to clean the top deck and the chamber door.

Control Panel

To clean the control panel, spray a small amount of a mild cleaning liquid (such as window cleaner) on a clean cloth and wipe the panel clean. DO NOT spray cleaners directly on the control panel.

Door Seal

Open the chamber door all the way and wipe down the door seal and door runners using a mild *nonalkaline* detergent (such as dishwashing liquid) and warm water. Keep the door runners dry and clean.

Front Vents

To maintain the efficiency of the refrigeration system, keep the front vents free of dust and dirt and anything that might block the air intake. At one to three month intervals, clean the vents with a brush, cloth or vacuum cleaner.

Lubrication

All components are prelubricated and require no further lubrication. The refrigeration unit is hermetically sealed and the ball bearings in the centrifuge motor and drive are permanently lubricated.

**WARNING**

When the main power shuts off, the brake will not operate. Wait until the rotor stops before using the mechanical override. Reaching into the rotor chamber while the rotor is spinning can cause personal injury. Anything that falls into the chamber may be ejected at high speed.

Emergency Sample Recovery

If a power failure or system malfunction causes the centrifuge to shut off while the rotor is spinning, the rotor chamber door will not unlatch. A mechanical override is provided to allow sample recovery in the case of an emergency. This procedure is intended for emergency recovery purposes only; do not use routinely.

The door latch override is a small recess located on the rear deck of the centrifuge (see illustration). To open the chamber door:

1. Be sure the rotor has coasted to a complete stop.
2. Insert a straightened paperclip straight down into the door interlock override hole and push down.
3. Open the chamber door.

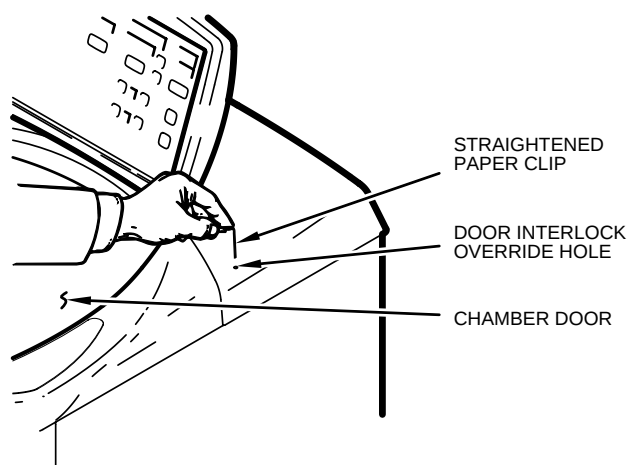


Figure 5-1. Door Interlock Override

Parts Ordering Information

To order replacement parts: in the United States, telephone toll-free 800-522-7746. Outside the United States, contact local distributor or agent. Be sure to provide a description of the part, centrifuge model, and centrifuge serial number.

**WARNING**

Because of the characteristics of the samples likely to be processed in this centrifuge, biological or radioactive contamination may occur. Always be aware of this possibility, and take normal precautions. Use appropriate decontamination procedures should exposure occur.

Service Decontamination Policy

If a centrifuge or rotor that has been used with radioactive or pathogenic material requires servicing by Kendro personnel, either at the customer's laboratory or at a Kendro facility, comply with the following procedure to ensure the safety of all personnel:

1. Clean the equipment to be serviced of all encrusted material and decontaminate it (see Care and Maintenance section of centrifuge or rotor instruction manual) prior to servicing by the Kendro representative or returning it to the Kendro facility. There must be no radioactivity detectable by survey equipment.

The SORVALL® Product Guide contains descriptions of commonly used decontamination methods and a chart showing method compatibility with various materials. The Care and Maintenance Section of the centrifuge or rotor instruction manual contains specific guidance about cleaning and decontamination methods appropriate for the product it describes.

Clean and decontaminate your centrifuge or rotor as follows:

For lowspeed, superspeed, and SUPRAspeed® floor model centrifuges:

- a. Remove rotor from the rotor chamber.
- b. Remove, wash, and decontaminate motor sealing gasket and pad.
- c. Drain line plugs and clean drain line (if any).
- d. Decontaminate lid, rotor chamber, and drive using an appropriate method.
- e. Remove all encrusted material from around the motor and drive assemblies.

For rotors:

Remove tubes, bottles, and adapters from the rotor and decontaminate rotor using an appropriate method. If tubes or rotor caps are stuck in the rotor, or the rotor lid is stuck, notify Kendro representative; be prepared with the name and nature of the sample so the Kendro Chemical Hazards Officer can decide whether to authorize the rotor's return to a Kendro facility.

Do not leave a loaded rotor locked inside a centrifuge that requires servicing. If, with a loaded rotor installed in the chamber, a centrifuge malfunction makes it so that the chamber door will not open by normal means, follow the Emergency Sample Recovery procedure found in your centrifuge operating instructions manual to gain access to the rotor.

2. Complete and attach Decontamination Information Certificate (in the back of your rotor or instrument manual) to the centrifuge or rotor before servicing.

Decontamination Information Certificates are included with this book. Additional certificates are available from the local Kendro Representative or Field Service Engineer. In the event these certificates are not available, a signed, written statement certifying that the unit has been properly decontaminated, identifying what the contaminants were and outlining the decontamination procedures used will be acceptable.

NOTE: The Field Service Engineer will note on the Customer Service Repair Report if decontamination was required and, if so, what the contaminant was and what procedure was used. If no decontamination was required, it will be so stated.

If a centrifuge or rotor to be serviced does not have a Decontamination Information Certificate attached and, in Kendro's opinion presents a potential radioactive or biological hazard, the Kendro representative will not service the equipment until proper decontamination and certification is complete.

If the centrifuge or rotor must be returned to a Kendro facility:

1. Contact your Kendro representative to obtain an Equipment Return Decontamination Form; be prepared with the name and serial number of the centrifuge or rotor and the repairs required.
2. Complete the Equipment Return Decontamination Form and returned it to Kendro. Upon receipt of a completed form, a Returned Material Authorization Number (RMA Number) will be issued to you.
3. With the RMA Number clearly marked on the outside of packaging, send the items to the address obtained from your Kendro representative.

NOTE: United States federal regulations require that parts and instruments *must* be decontaminated before being transported. Outside the United States, check local regulations.

If equipment is received at Kendro facilities without a valid RMA Number on the outside of the shipping container and a completed Equipment Return Decontamination Form on file, the equipment will be treated as a potential contamination hazard, and will not be serviced until decontamination certification has been completed. The sender will be contacted for instructions regarding disposition of the equipment in question; all disposition costs will be borne by the sender. If contaminated equipment is received at Kendro facilities, both the carrier and appropriate authorities shall be notified.

Chapter 6: Messages and Diagnostics

This chapter itemizes the information that may be conveyed to you in the course of a run, including messages, faults and warning messages.

Run Status Indicators

The following information appears on the control panel at different times to inform you of run conditions and requirements:

Message	Field	Explanation/Action
End	Run Speed	Run has ended and it is safe to open the chamber door.
Error	Run Speed	Run has ended abnormally due to an error condition. A descriptive message also appears in the Rotor/Message Display.
-----	Set Rotor	Indicates that a rotor needs to be identified. Displays when: • The centrifuge is first powered on; • A run ends and the chamber door has been opened.

Another indicator is the long beep which sounds at the end of each run. This indicates that the chamber door is unlocked and it is safe to open the door.

Informational and Error Messages

A number of different messages may appear on the Rotor/Message Display. Some messages inform you of a specific run condition, such as when a rotor imbalance is detected. Other messages warn of internal problems with the centrifuge that warrant a service call.

Messages scroll across the lower line of the Rotor/Message Display, replacing the rotor type, and are accompanied by three audible beeps. Make a note of the message, then press the CLEAR key to clear the display and redisplay the rotor type.

- NOTE:**
1. Some messages clear on their own if the system is able to self-correct the condition.
 2. If more than one condition is being reported, a secondary message displays when you clear the display. Continue pressing CLEAR (recording each message) until the rotor type redisplay, the CLEAR light goes out and the TYPE light is lit.

Table 6-1 below and on the next four pages alphabetically itemizes the messages which may appear on the Rotor/Message Display and provides a description of each with the action required .

Reporting Error Conditions

If a service call is necessary, make a note of the error message(s) before clearing the display. Your service representative needs to know each error listed in order to identify and troubleshoot the error condition.

Table 6-1. Evolution™ RC Error Messages

ACCELEROMETER FAULT Imbalance detector communication failed. (Error 003) <i>Major fault: run will terminate and rotor will brake to stop; fault can be cleared after stop.</i> Contact Kendro Service.	CHAMBER TOO COLD Chamber temperature was below –19°C. (Error 046) <i>Major fault: run will terminate and rotor will brake to stop; fault can be cleared after stop.</i> Contact Kendro Service.
AUXTACH I/O ERROR Secondary tachometer communication failed. (Error 034) <i>Minor fault/advisory: operation will continue; message can be cleared at any time.</i> Contact Kendro Service.	CHAMBER TOO HOT Chamber temperature was above 49°C. (Error 045) <i>Major fault: run will terminate and rotor will brake to stop; fault can be cleared after stop.</i> Contact Kendro Service.
AUXTACH SHUTdOWN Auxiliary tachometer indicated speed of 800 rpm or more over the selected rotor's top speed. (Error 033) <i>Serious malfunction: run will terminate and rotor will coast to stop; in most cases, power will be removed from all circuits and display will go blank. Cannot be cleared.</i> Cycle power OFF/ON. If centrifuge does not complete start-up or if fault recurs, contact Kendro Service.	CLOSE dOOR An open chamber door disabled the run. (Error 004) <i>Major fault: run will terminate and rotor will brake to stop; fault can be cleared after stop.</i> If "START" was pressed without the chamber door fully closed, close the door and select the appropriate rotor. Otherwise, contact Kendro Service.
bAd ROTOR FILE Software rotor file is corrupted. (Error 037) <i>Serious malfunction: the system will not run. Cannot be cleared.</i> Cycle power OFF/ON. If fault recurs, contact Kendro Service.	dOOR NOT LOCKEd After a lock command was issued, the door latch remained unlocked (as if mechanical override used). (Error 005) <i>Major fault: run will terminate and rotor will brake to stop; fault can be cleared after stop.</i> If not the result of using the mechanical override, contact Kendro Service.
bAd RUNFILE Software run file is corrupted. (Error 039) <i>Minor fault/advisory: operation will continue; message can be cleared at any time.</i> Contact Kendro Service.	

(continued)

Table 6-1. Evolution™ RC Error Messages (continued)**DOOR NOT UNLOCKEd**

After an unlock command was issued, the door latch remained locked. (Error 006)

Minor fault/advisory: operation will continue; message can be cleared at any time.

May indicate that the door latch arm is obstructed and is unable to move. Make sure that the door is not pressing against the door latch arm – close the door fully, clear the fault, and open the door. Otherwise, contact Kendro Service.

DRVbOX FAULT

Drivebox internal problem. (Error 032)

Major fault: run will terminate and rotor will brake to stop; fault can be cleared after stop.

Contact Kendro Service.

ENERGY EXCEEDEd

During acceleration, the Energy Management System determined that, at SET speed, the energy of the installed rotor would exceed the centrifuge maximum. (Error 018)

Major fault: run will terminate and rotor will brake to stop; fault can be cleared after stop.

May indicate that the SET rotor is not the rotor installed. Make sure the rotor specified on the control panel matches the installed rotor, and that the installed rotor loads are according to the instructions in the rotor manual. May also indicate that the motor has overheated; check other faults (see MOTOR TOO HOT on next page). Otherwise, contact Kendro Service.

FAILED TO MAKE SPEED

Centrifuge was unable to reach SET speed. (Error 015)

Minor fault/advisory: operation will continue; message can be cleared at any time.

May indicate that the installed rotor does not match SET rotor; SET speed was calculated to be lower than the centrifuge energy limit, but higher than rotor windage will allow. Make sure the rotor specified on the control panel matches the installed rotor. Otherwise, contact Kendro Service.

IIC bUS LOCKEd

The major communication (I²C) bus is locked-up. (Error 036)

Serious malfunction: run will terminate and rotor will coast to stop; cannot be cleared.

Cycle power OFF/ON. If fault recurs, contact Kendro Service.

IMbALANCE FAULT

The imbalance signal from the accelerometer exceeded the maximum for the rotor. (Error 002)

Major fault: run will terminate and rotor will brake to stop; fault can be cleared after stop.

Typically indicates an unbalanced load in the rotor. Make sure opposing compartment loads are balanced according to instructions in the Rotor Manual, that tubes/bottles are orientated correctly and properly loaded according to instructions in the manual. Also, make sure that the rotor cover (if any) is properly installed on the rotor, that the rotor is properly seated on the tapered drive spindle, and that the rotor locking knob(s) are tightened securely. If the rotor is properly balanced, this fault may indicate an accelerometer failure or that the tapered drive spindle or gyro is damaged. Contact Kendro Service.

KE CAL ERROR

Programmed-in motor torque constant (K_e) calibration value is out of range. (Error 038)

Minor fault/advisory: operation will continue; message can be cleared at any time.

Contact Kendro Service.

KE GAIN ERROR

Programmed-in motor torque constant (K_e) gain value is out of range. (Error 040)

Minor fault/advisory: operation will continue; message can be cleared at any time.

Contact Kendro Service.

KE I/O ERROR

K_e P.C. board communication failed. (Error 011)

Major fault: run will terminate and rotor will brake to stop; fault can be cleared after stop.

Contact Kendro Service.

(continued)

Table 6-1. Evolution™ RC Error Messages (continued)**MOTOR TOO HOT**

Motor temperature was above 150°C.(Error 016)

Major fault: run will terminate and rotor will brake to stop; fault can be cleared after stop.

If multiple runs have been performed while using a large rotor with short rest periods, allow the motor to cool, then restart the run. Allowing more time between runs can prevent recurrence. Otherwise, contact Kendro Service.

NO AIR SENSOR

Chamber air temperature sensor communication failed. (Error 012)

Major fault: run will terminate and rotor will brake to stop; fault can be cleared after stop.

Contact Kendro Service.

NO TACH SIGNAL

Main tachometer communication failed. (Error 019)

Serious malfunction: run will terminate and rotor will coast to stop; cannot be cleared.

Cycle power OFF/ON. If fault recurs, contact Kendro Service.

OVER ROTOR SPEED

Speed was more than 500 rpm over rotor maximum. (Error 024)

Major fault: run will terminate and rotor will coast to stop; fault can be cleared after stop.

Contact Kendro Service.

OVER SPEED

Speed was more than 500 rpm over SET. (Error 021)

Major fault: run will terminate and rotor will coast to stop; fault can be cleared after stop.

Contact Kendro Service.

PFC I2C FLT

Power factor correction (PFC) module I²C communication failed. (Error 031)

Minor fault/advisory: operation will continue; message can be cleared at any time.

Contact Kendro Service.

PFC 18 V FLT

Power factor correction (PFC) module internal 18V supply was out of range. (Error 028)

Minor fault/advisory: operation will continue; message can be cleared at any time.

Contact Kendro Service.

PFC 400 V FLT

Power factor correction (PFC) module voltage was below 385V; indicates an overcurrent condition. (Error 026)

Minor fault/advisory: operation will continue; message can be cleared at any time.

Contact Kendro Service.

PFC b V FLT

Loaded supply line voltage was less than 175V. (Error 027)

Minor fault/advisory: operation will continue; message can be cleared at any time.

Indicates that incoming line voltage is too low. Incoming loaded line voltage must be within centrifuge requirements (187–253 Vac).

PFC OVERLOAD

Power factor correction (PFC) module input line current was too high. (Error 029)

Minor fault/advisory: operation will continue; message can be cleared at any time.

Contact Kendro Service.

PFC OVERTEMP

Power factor correction (PFC) module temperature was too high. (Error 030)

Minor fault/advisory: operation will continue; message can be cleared at any time.

Contact Kendro Service.

PFC SCI FLT

Power factor correction (PFC) module internal communication failed. Error 025)

Minor fault/advisory: operation will continue; message can be cleared at any time.

Contact Kendro Service.

(continued)

Table 6-1. Evolution™ RC Error Messages (continued)**POWER FAILURE**

Power outage occurred, speed was below 1000 rpm when power was restored; run terminated. (Error 013)

Minor fault/advisory: operation will continue; message can be cleared at any time.

Clear the fault and the run can be restarted.

POWER RESUMEd

Power outage occurred, speed was above 1000 rpm when power was restored; run resumed. (Error 014)

Minor fault/advisory: operation will continue; message can be cleared at any time.

Clear the fault.

ROTOR OVER TEMP

Estimated sample temperature was more than 10°C over SET for 10 minutes. (Error 008)

Major fault: run will terminate and rotor will brake to stop; fault can be cleared after stop.

Contact Kendro Service.

ROTOR UNDER TEMP

Estimated sample temperature was more than 10°C under SET for 10 minutes. (Error 010)

Major fault: run will terminate and rotor will brake to stop; fault can be cleared after stop.

Contact Kendro Service.

SENSOR GAIN ERROR

Programmed-in temperature sensor gain value is out of range. (Error 041)

Minor fault/advisory: operation will continue, although continued operation could subject sample to extreme temperatures; message can be cleared at any time.

Contact Kendro Service.

SENSOR OFFSET ERROR

Programmed-in temperature sensor offset value is out of range. (Error 042)

Minor fault/advisory: operation will continue, although continued operation could subject sample to extreme temperatures; message can be cleared at any time.

Contact Kendro Service.

SPEED CEILING EXCEEDed

Rotor speed was more than 26 500 rpm. (Error 022)

Major fault: run will terminate and rotor will coast to stop; fault can be cleared after stop.

Contact Kendro Service.

SPEED CHANGE TOO LARGE

Improbable speed change occurred, may be caused if no rotor is installed. (Error 020)

Serious malfunction: run will terminate and rotor will coast to stop; cannot be cleared –cycle power OFF/ON, if fault recurs, contact Kendro Service.

Make sure that the specified rotor is properly installed on the tapered drive spindle. Otherwise, contact Kendro Service.

SPEED CLIMb IN dECeL

Speed increased when it should have been decreasing. (Error 023)

Major fault: run will terminate and rotor will coast to stop; fault can be cleared after stop.

Contact Kendro Service.

SPEED dRIFTING

Centrifuge was not able to properly control rotor speed. (Error 047)

Minor fault/advisory: operation will continue; message can be cleared at any time.

Contact Kendro Service.

SPEED LIMITED RUN

During acceleration, the Energy Management System was unable to determine the energy of the installed rotor, so motor torque was reduced. Acceleration will be affected, so it will take longer to reach SET speed; in some cases, large rotors may not be able to achieve their top speed. Situation poses no hazard to the user. (Error 017)

Minor fault/advisory: operation will continue; message can be cleared at any time.

May indicate that observed performance of the installed rotor is out of range for the rotor that is programmed. Make sure the rotor specified on the control panel matches the installed rotor, and that the installed rotor loads are according to the instructions in the rotor manual. Otherwise, contact Kendro Service.

(continued)

Table 6-1. Evolution™ RC Error Messages (continued)**SYSTEM FILE ERROR**

No hard disk read/write, can't open file; memory may be full or the run/fault log may be corrupted. (Error 001)

Minor fault/advisory: operation will continue; message can be cleared at any time.

Contact Kendro Service.

TACH MISMATCH

The main and secondary tachometers do not agree. (Error 035)

Serious malfunction: run will terminate and rotor will coast to stop; cannot be cleared.

Cycle power OFF/ON. If fault recurs, contact Kendro Service.

TEMP GAIN ERROR

Programmed-in temperature gain value is out of range. (Error 043)

Minor fault/advisory: operation will continue, although continued operation could subject sample to extreme temperatures; message can be cleared at any time.

Contact Kendro Service.

TEMP OFFSET ERROR

Programmed-in temperature offset value is out of range. (Error 044)

Minor fault/advisory: operation will continue, although continued operation could subject sample to extreme temperatures; message can be cleared at any time.

Contact Kendro Service.

Appendix

Rotor Information

Rotor Type / Name	Maximum Speed (rpm)	Maximum RCF (g-force)	K Factor ¹	Critical Speed (rpm)	Rotor Capacity (places x ml)	Maximum Compartment Mass (grams)	r _{max} (cm)	r _{min} (cm)
FIXED ANGLE								
SS-34	20 500	50 228	714	1400	8 x 50	115	10.70	3.27
SLA-3000	12 000	24 336	2364	900	6 x 500	780	15.13	3.94
SLA-1500	15 000	34 155	1475	1200	6 x 250	420	13.59	3.66
SLA-1000	16 500	35 793	1725	1200	4 x 250	400	11.77	1.84
SLA-600TC	13 000	27 750	913	1200	12 x 50	74	14.70	7.99
SLC-6000	8500	15 810	3549	1000	6 x 1000	1500	19.59	5.42
SLC-4000	9000	15 182	4631	750	4 x 1000	1500	16.78	2.53
SLC-3000	10 000	17 604	3394	975	6 x 500	780	15.76	4.12
SLC-1500	14 000	29 994	1676	1000	6 x 250	420	13.70	3.74
SA-800	20 500	49 054	560	1550	8 x 100	162	10.45	4.12
SA-600	17 000	41 837	747	1250	12 x 50	115	12.96	5.52
SA-512	19 500	48 930 ²	394 ²	1450	(16+16) x 16	30	11.52 ²	6.37 ²
SA-300	25 000	67 509	573	1600	6 x 50	115	9.67	2.35
SM-24	20 500	51 965 ²	434 ²	1450	(16+8) x 16	27	11.07 ²	5.38 ²
SE-12	26 000	70 450	335	1950	12 x 14	30	9.33	3.81
F-20/MICRO	20 000	51 427	187	1450	32 x 1.5	3	11.51	8.57
GS-3	9 000	13 689	4203	850	6 x 500	780	15.13	3.94
GSA	13 000	27 485	2023	1000	6 x 250	580	14.56	3.77
F-16/250	14 500	31 939	1576	1150	6 x 250	420	13.60	3.67
F-28/50	20 000	51 248	660	1350	10 x 50	115	11.47	4.04
F-28/36	18 000	41 366	480	1350	12 x 36	66	11.43	6.18
F-28/13	19 500	48 548	295	1500	16 x 13.5	23	11.43	7.34
SWINGING BUCKET								
SH-3000	4 700	4 575	8138	1450	4 x 750	1805 ³	18.54	9.11
SH-3000 M (microplates)	4 700 ⁴	3 706 ⁴	—	1550	4 x 3 standard 96-well plates	987 ³	15.02	—
HB-6	13 000	27 617	1765	1350	6 x 50	164	14.63	4.50
HS-4 1PL	7 500	10 826	3912	1150	4 x 250	1035 ³	17.23	7.22
HS-4 3PL	7 500	10 725	3870	1150	12 x 50	1035 ³	17.07	7.22
HS-4 4PL	7 500	11 071	3866	1150	16 x 50	1035 ³	17.62	7.46
HS-4 24PL	7 500	9 249	2643	1150	96 x 5	1035 ³	14.72	8.18
SH-80	20 000	45 395	400	1500	8 x 10	78	10.16	5.40
HB-4	13 000	27 712	1667	1400	4 x 50	250 ³	14.68	4.82
OTHER								
SS-34/KSB-R	20 000	47 808	750	1300	8 x 50	1.2 g/ml	10.70	3.27
SV-288	20 000	40 301	210	1400	8 x 36	50	9.02	6.47
SV-80	19 000	40 969	98	1300	16 x 5	6.4	10.16	8.84
TZ-28	20 000	42 580	612	1200	1 x 1350	1620	9.53	3.62
TZ-28/GK	19 000	38 428	678	1100	1 x 1350	1.2 g/ml	9.53	3.62

¹ With maximum allowable volume at maximum speed.

² Outer row.

³ Includes the weight of the bucket or carrier.

⁴ Maximum for rotor; actual top speed will typically be less, limited by the microplates used.

Warranty

Kendro Laboratory Products, L.P. makes no warranty of any kind, expressed or implied, except as stated in this warranty policy.

The SORVALL® Evolution™ RC Superspeed Centrifuge is warranted to be free from defects in material and workmanship for a period of one year from the date of delivery. The compressor, condenser, evaporator and all interconnecting tubing are warranted to be free of defects in material and workmanship for a period of five years from the date of delivery. The drive motor is warranted to be free of defects in material and workmanship for a period of three years from date of delivery. Kendro will repair or replace and return free of charge any part which is returned to its factory within said period, transportation prepaid by user, and which is found upon inspection to have been defective in materials or workmanship.

This warranty does not apply to any damage to any instrument resulting from: normal wear and tear; misuse; abuse; use of electrical currents or circuits other than those specified on the plate affixed to the instrument; accident; negligence; failure to follow operating instructions; or use of any rotor other than a SORVALL® rotor intended for use in this instrument.

Kendro reserves the right to change, alter, modify or improve any of its instruments without any obligation whatsoever to make corresponding changes to any instrument previously sold or shipped.

The foregoing obligations are in lieu of all other obligations and liabilities including negligence and all warranties, of merchantability or otherwise, expressed or implied in fact or by law, and state our entire and exclusive liability and buyer's exclusive remedy for any claim or damages in connection with the sale of furnishing of goods or parts, their design, suitability for use, installation or operation. Kendro will in no event be liable for any special or consequential damages whatsoever, and our liability under no circumstances will exceed the contract price for the goods for which liability is claimed.

NOTES

DECONTAMINATION INFORMATION CERTIFICATE

Complete and attach to equipment **BEFORE** servicing (instructions on reverse)

PLEASE PRINT

DECONTAMINATION
CERTIFIED BY _____ TITLE/POSITION _____
PHONE _____ FAX _____ DEPARTMENT _____
INSTITUTION _____ ADDRESS _____
CITY _____ STATE _____ ZIP _____
INSTRUMENT _____ SERIAL NUMBER _____
ROTOR _____ SERIAL NUMBER _____
PART _____ PART NUMBER _____
HAZARDOUS CONTAMINANT(S) _____ DECONTAMINATION DATE _____
DECONTAMINATION METHOD(S) _____
DECONTAMINATION
CERTIFIER'S SIGNATURE _____ DATE _____

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CERTIFIER'S SIGNATURE _____ DATE _____

INSTRUCTIONS

When an instrument that has been used with radioactive, pathogenic, or otherwise hazardous materials requires servicing by Kendro personnel either at the customer's laboratory or at Kendro facilities, the following procedure must be complied with to insure safety of our personnel:

1. The instrument or part to be serviced shall be cleaned of all blood and other encrusted material and decontaminated prior to servicing by our representative. No radioactivity shall be detectable by survey equipment.
2. A Decontamination Information Certificate shall be completed and attached to the instrument or part.

If an instrument or part to be serviced does not have a Decontamination Information Certificate attached to it, and, in our opinion, presents a potential radioactive or biological hazard, our representative will not service the equipment until proper decontamination

and certification has been completed. If an instrument is received at our Service facilities and, in our opinion, poses a radioactive or biological hazard, the sender will be contacted for instructions as to disposition of the equipment. Disposition costs will be borne by the sender.

Decontamination Information Certificates are included with these Operation Instructions. Additional certificates are available from your local technical or customer service representative. In the event these certificates are not available, a written statement certifying that the instrument or part has been properly decontaminated and outlining the procedures used will be acceptable.

NOTE Kendro Service representatives will indicate on a Customer Service Repair Report if decontamination was required, and if so, what the contaminate was and what procedure was used. If no decontamination was required, it should be so stated.

6/00

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