

# ***SILENCER***®

## **TANK-ROVER Series**

### **Service Manual**



Proudly designed and manufactured in the great United States

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# Table Of Contents

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Chapter 1	Getting Started .....	1-1
	Scope .....	1-1
	Unpacking And Inspection.....	1-1
	Setup.....	1-1
	Rotor Installation .....	1-2
	Rotor Imbalance Sensor .....	1-2
Chapter 2	About The TANK / ROVER.....	2-1
	Purpose .....	2-1
	Description .....	2-1
Chapter 3	Using The TANK / ROVER .....	3-1
	Orientation.....	3-1
	Controls .....	3-1
	Operation .....	3-2
	Set Point .....	3-3
	Program Store .....	3-3
	Program Recall .....	3-4
	Settings Menu .....	3-4
	Operation Tips .....	3-5
	Operation Flowchart .....	3-7
Chapter 4	Care Of The TANK / ROVER .....	4-1
Chapter 5	Troubleshooting .....	5-1
	Status Codes .....	5-1
	Error Reset.....	5-1
	Troubleshooting Table .....	5-1
Chapter 6	Functional Description .....	6-1
	AC Power Distribution .....	6-1
	DC Power Distribution .....	6-1
	Operator Interface Circuits.....	6-2
	Imbalance Sensor Circuit .....	6-2
	Lid Interlock Circuit .....	6-2
	Lid Unlocking Circuit .....	6-3
	Tachometer Feedback Circuit .....	6-3
	Motor Control Circuit .....	6-3
	Motor Driver Temperature Sense Circuit .....	6-3
	Motor Current Sense Circuit .....	6-4
	Fan Control .....	6-4

	Motor Braking Circuit.....	6-4
Chapter 7	Technical Illustrations.....	7-1
Chapter 8	Parts Replacement Procedures .....	8-1
	Precautions .....	8-1
	Equipment .....	8-1
	Motor .....	8-1
	Display/Control PCB .....	8-3
	Power PCB .....	8-3
	Imbalance Sensor .....	8-3
	Lidlock Assembly .....	8-4
	Drive / Brake Relay .....	8-4
	Drive / Brake Relay Socket.....	8-4
Chapter 9	Warranty .....	9-1
Appendix A	Specifications .....	A-1
	Performance Specifications.....	A-1
	Unit Specifications.....	A-2
Appendix B	R. C. F. Chart .....	A-3
Appendix C	Service Log .....	A-5
Appendix D	Replacement Parts List .....	A-6
Appendix E	Lid Release Tool.....	A-7
Appendix F	Care of Rotor & Accessories .....	A-8
Appendix G	Imbalance Sensor Assembly Testing .....	A-10
Appendix H	Motor Hall Effect Sensor Testing .....	A-13

# List of Illustrations

---

Figure 3.1	Control Panel Layout .....	3-1
Figure 3.3	Operation Flowchart .....	3-7
Figure 7.1	Wiring Diagram .....	7-1
Figure 7.2	Power PCB Schematic .....	7-2
Figure 7.3	Power PCB Layout .....	7-3
Figure 7.4	Display / Control PCB Schematic .....	7-4
Figure 7.5	Display / Control PCB Layout .....	7-5
Figure 7.6	Drive / Brake Relay Socket Wiring.....	7-6
Figure 8.1	Front Panel Retaining Screws .....	8-2
Figure 8.2	Motor Gasket Removal .....	8-2
Figure 8.3	Motor Retaining Screws .....	8-2
Figure G.1	Imbalance Sensor Assembly .....	A-12
Figure G.2	Imbalance Plate Adjustment .....	A-12
Figure G.3	Imbalance Plate Adjustment .....	A-12

## Chapter 1

# Getting Started

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## SCOPE

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This manual contains information with regards to application, installation, operation, and care of the Silencer® TANK benchtop and ROVER floor model centrifuges, and must be read prior to setup or operation of the centrifuge.

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## UNPACKING AND INSPECTION

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Your new Silencer® centrifuge is packed in a specially designed shipping carton. Upon arrival please check the condition of carton and note any damage. Keep all packing materials for the warranty period of the centrifuge.

After unpacking your Silencer® carefully inspect it for damage. It is your responsibility to report all damages to the transportation company and filing, if necessary, any damage claims.

At this point take a moment to ensure you have received the correct rotor, tube adapters, etc. If not or if you have any questions regarding compatibility with your tubes, please contact GFMD, Ltd. at 800-323-4306 before proceeding.



## WARNING

Do not operate this equipment in a combustible atmosphere!

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## SETUP

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For your own safety and to prevent damage to the centrifuge, be sure to read this manual before continuing with setup or operation of this centrifuge.

For smooth operation and long equipment life, choose a stable and level location.

Avoid sources of heat and/or moisture such as sinks, water baths, heating ducts, and direct sunlight. A suitable environment is 20° to 25° C (68° to 77° F) with a relative humidity range of 30% to 60%. The minimum clearance is 6" on all sides. A cooler ventilated location and leaving the lid open between cycles will allow longer and/or more frequent cycles without overheating of samples. The maximum number of cycles that may be run consecutively will depend upon operating speed, set time, ventilation around the centrifuge, and ambient temperature. Samples that may be adversely affected by being warmed to 39°C during centrifugation should be centrifuged in a refrigerated centrifuge such as the Silencer® TANK-R or ROVER-R.

Plug the power cord into a properly grounded outlet and turn on main power interrupt (on back of unit next to power cord). For safety, equipment life, and proper performance, your Silencer® TANK / ROVER's power requirements are 115V AC, 10 amperes, 60Hz. The power cord must be UL listed or CSA certified, 16 AWG, and 6' 7" or less in length.

# Getting Started

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## WARNING

Operating the centrifuge without proper grounding can cause dangerous electrical conditions and could result in serious operator injury!

## CAUTION

Operation of centrifuge on an emergency power circuit can cause damage to electronic circuits.

## CAUTION

Operation of centrifuge on a power strip increases ground resistance and can cause damage to electronic circuits.

---

## ROTOR INSTALLATION

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Insert the rotor onto the motor shaft ensuring the alignment pin in the motor shaft fits correctly into the alignment groove in the bottom of the rotor. The rotor must be installed correctly for proper operation.

Replace the rotor securing nut. The nut must be securely tightened.



## WARNING

Failure to securely tighten the rotor securing nut may result in damage to the centrifuge and/or operator injury!

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## ROTOR IMBALANCE SENSOR

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The rotor imbalance sensor is factory preset, but may require minor adjustment upon installation. Contact GFMD, Ltd. at 800-323-4306 for assistance if adjustment is required.

## Chapter 2

# About The TANK / ROVER

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## PURPOSE

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The Silencer<sup>®</sup> TANK / ROVER is a quiet, general purpose centrifuge designed to be used to accelerate sample separation through the application of relative centrifugal force (RCF). This product is not intended to diagnose, treat, cure or prevent any disease.

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## DESCRIPTION

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The direct drive system employs a powerful, specially designed, balanced, brushless motor ensuring a smooth quiet operation spanning the full speed range of the instrument. This design also promotes long bearing life and eliminates brush maintenance, thereby reducing operating costs.

Excellent stability against imbalance is achieved due to special vibration absorbing drive assembly mounts.

The operator and the TANK / ROVER are protected by several safety features:

- The centrifuge cannot be started with the lid open.
- The centrifuge will not run if the lidlock fails to securely lock.
- Once the rotor is in motion the lid cannot be opened until the rotor has stopped.
- The see-through high-strength lid allows the operator to view the rotor chamber without opening the lid.
- The high-strength alloy rotor chamber is strong and easy to clean.
- The imbalance detector shuts the centrifuge down in case of a severe imbalance and gives the operator a visual indicator.

For complete equipment specifications see Appendix A.



## Chapter 3

# Using The TANK / ROVER

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## ORIENTATION

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Take time now to acquaint yourself with the TANK / ROVER's displays and controls. The basic operation is very simple and the controls are mostly self-explanatory.

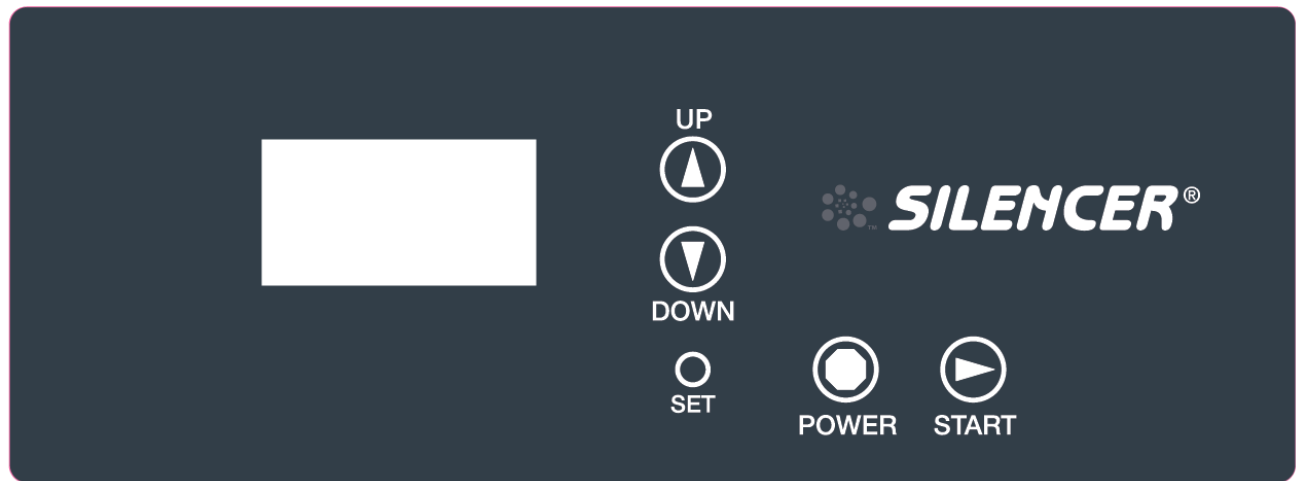


Figure 3.1

## WARNING

Turning the power off does not remove power to the centrifuge. Remove all power to the unit by unplugging the power cord.

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## CONTROLS

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### POWER

Press the POWER button once to bring the unit out of SLEEP mode and into STANDBY mode. This unlocks the lid and turns the display on. Pressing the POWER button while the power is on turns the display off and puts the unit into a low power SLEEP mode.

Pressing the POWER button during a run cycle stops the cycle.

Pressing the POWER button while in any SET mode cancels and returns the centrifuge to the STANDBY MODE.

### SET

Press to enter the SET POINT mode

### UP

Press the UP button to increase the value of the selected item.

# Using The TANK / ROVER

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## DOWN

Press the DOWN button to decrease the value of the selected item.

## START

If pressed when the unit is in the STANDBY mode, the START button will start the run cycle, which is indicated by the display going into inverse mode (dark background and light text).

Pressing the START button while in any SET mode will accept changes and return to the STANDBY mode.



## WARNING

Do not operate this equipment in a combustible atmosphere!

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## OPERATION

---

Chapter 1 must be read and the TANK / ROVER must be setup accordingly before continuing.

Press the POWER button to bring the centrifuge out of the SLEEP mode, turn the display on, and unlock the lid.

2000 RPM / 800 x G  
5 MINUTES

The set speed and time defaults to the last saved speed and time setting. The settings can be changed in the SET POINT mode or a saved program can be recalled in the PROGRAM RECALL mode.

Open the lid and load your samples, taking care to maintain a balanced load. A rotor must never be run with buckets missing. The rotor and four buckets are a five piece, balanced system. All opposing loads must balance to within 10 grams. If opposing buckets are run with a partial load of tubes in their inserts, the tubes must be arranged symmetrically both with respect to the pivotal axis of each bucket, and across the center of rotation.

Care must be taken to ensure that plastic tubes are loaded opposite plastic tubes and glass tubes are loaded opposite glass tubes due to the considerable difference in weight of plastic and glass.

For examples of balanced and unbalanced loads, see Fig. 3.2.

Balanced Loads ..... 1, 2, 3, 4, 5, and 6.

# Using The TANK / ROVER

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Unbalanced Loads ..... 7, 8 and 9.

Close the lid and press the START button. The lidlock will engage, the display will show the actual speed, and the centrifuge will accelerate to the set speed. Upon reaching the set speed the time will start counting down, and the display will show the time remaining.

When the set time has elapsed, the centrifuge will decelerate to a stop.

When the rotor has come to a complete stop the lidlock will release, and display will revert back to set speed and time.

---

## SET POINT

---

The SET POINT mode shows the current speed and time settings.

**NOTE:** The current settings can not be changed if the centrifuge is in the LOCKED mode.

```
SET POINTS
▶ RPM: 2000 RCF: 0800
TIME: 005 MINUTES
```

The currently selected item is indicated with an arrow. To select another parameter for modification press and release the SET button.

Modify the selected parameter by pressing the UP or DOWN button.

Cancel changes by pressing the POWER button.

Accept the changes and return to the STANDBY mode by pressing the START button.

If you wish to save these settings press and hold the SET button for approximately two seconds to enter the PROGRAM STORE mode (indicated by three short beeps).

---

## PROGRAM STORE

---

The PROGRAM STORE mode displays the three program locations.

```
PROGRAM - STORE
▶ PROG NUMBER: 1
  PROG NUMBER: 2
  PROG NUMBER: 3

RPM    TIME
2000   005
```

# Using The TANK / ROVER

---

The currently selected program is indicated with an arrow. Press the SET button to select another program location.

The current saved speed and time for the selected program is displayed below the program list.

Press the POWER button to cancel programming and return to the STANDBY mode.

Press the START button to store the settings into the selected program location and return to the STANDBY mode.

---

## PROGRAM RECALL

---

Press and hold the SET button for approximately 2 seconds to enter the PROGRAM RECALL mode (indicated by three short beeps).

The PROGRAM RECALL mode displays the three selectable programs.

PROGRAM - RECALL	
►	PROG NUMBER: 1
	PROG NUMBER: 2
	PROG NUMBER: 3
RPM	TIME
2000	005

The currently selected program is indicated with an arrow. Press the SET button to select another program location.

The programmed speed and time for the selected program is displayed below the program list.

Press the POWER button to cancel program selection and return to the STANDBY mode.

Press the START button to accept the program selection and return to the STANDBY mode.

---

## SETTINGS MENU

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Press the POWER button to put the centrifuge into the SLEEP mode (indicated by one beep).

Press and hold the SET button while pressing and releasing the POWER button.

Continue to hold the SET button until the unit enters the SETTINGS MENU (indicated by 2 short beeps)

Release the SET button.

# Using The TANK / ROVER

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```
SETTINGS MENU
▶ BEEPS (EOR):      1
  BEEPS (error):    5
  RCF MODE:         OFF
  BRAKES:           9
  OPTIONAL EOR LED: 2
```

The SETTINGS MENU shows the current user settings.

The currently selected item is indicated with an arrow. To select another parameter for modification press and release the SET button.

Modify the selected parameter by pressing the UP or DOWN button.

Accept the changes and return to the STANDBY mode by pressing the START button.

## **BEEPS (EOR)**

This determines the number of times the centrifuge will beep at the end of each run. The default is 1 and the allowable settings are 0 to 9.

## **BEEPS (error)**

This determines the number of times the centrifuge will beep when an error is incurred. The default is 5 and the allowable settings are 5 to 9.

## **RCF MODE**

This allows the operator to choose how speed will be set. If the RCF MODE is OFF the speed is set by RPM in 100 RPM increments. If the RCF MODE is ON the speed is set by RCF in increments of 10xg.

## **BRAKES**

This adjusts the braking level. The default is 9 and the allowable settings are OFF to 9.

## **OPTIONAL EOR LED**

This setting has no effect unless the optional End of Run Light is installed. This setting determines the length of time (in minutes) that the green LED will remain on at the end of each run. The default is 2 and the allowable settings are 0 to 99.

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## **OPERATION TIPS**

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- Do not drop or slam the lid!
- Use the emergency lid lock release only for emergencies.
- Only use the supplied emergency lid lock release tool.

# Using The TANK / ROVER

- Unplug the centrifuge before using the emergency lid lock release tool.
- Leave the lid open between cycles.

If there are any questions regarding operation please contact GFMD, Ltd. at 800-323-4306.

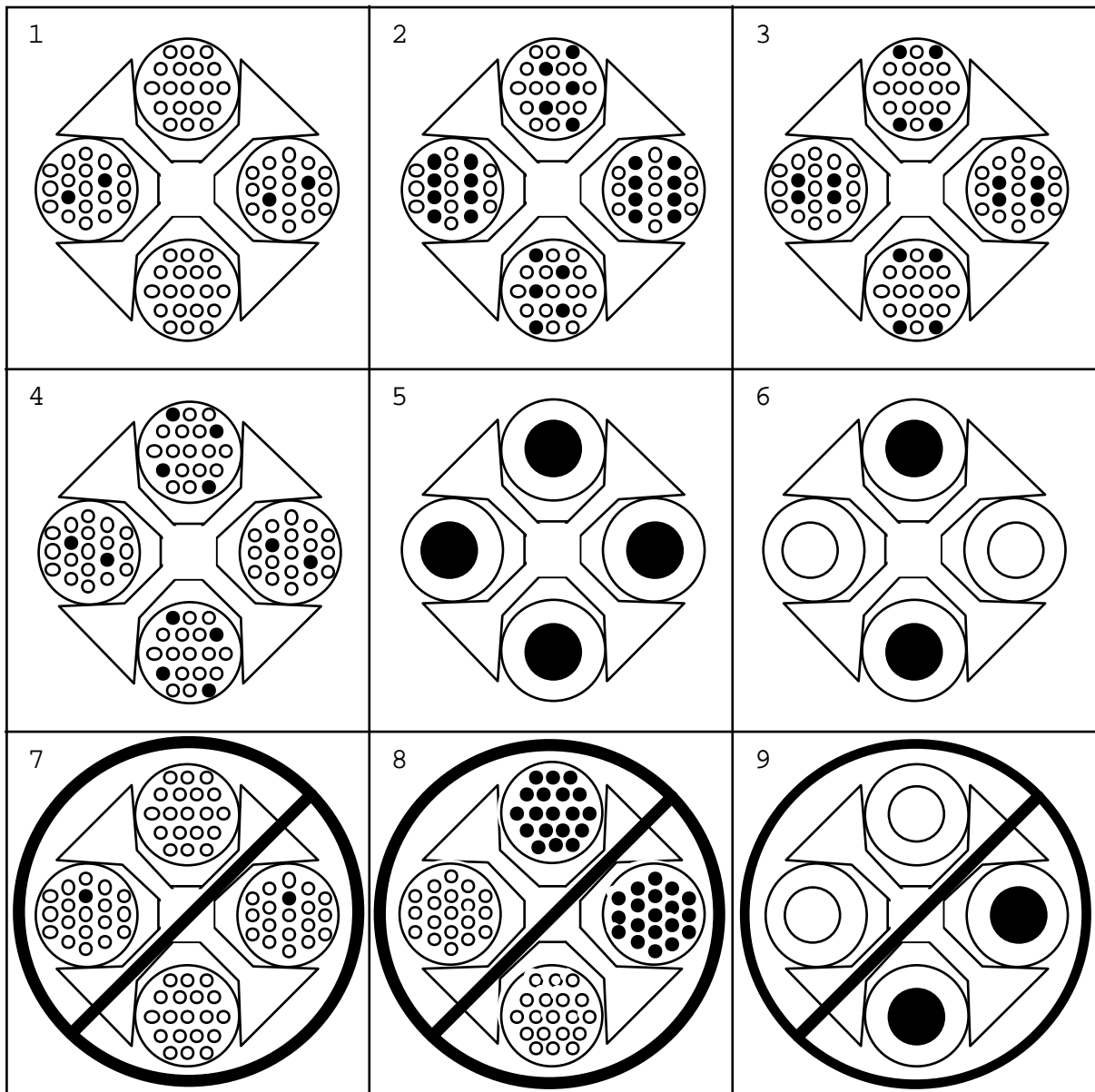


Figure 3.2

# Using The TANK / ROVER

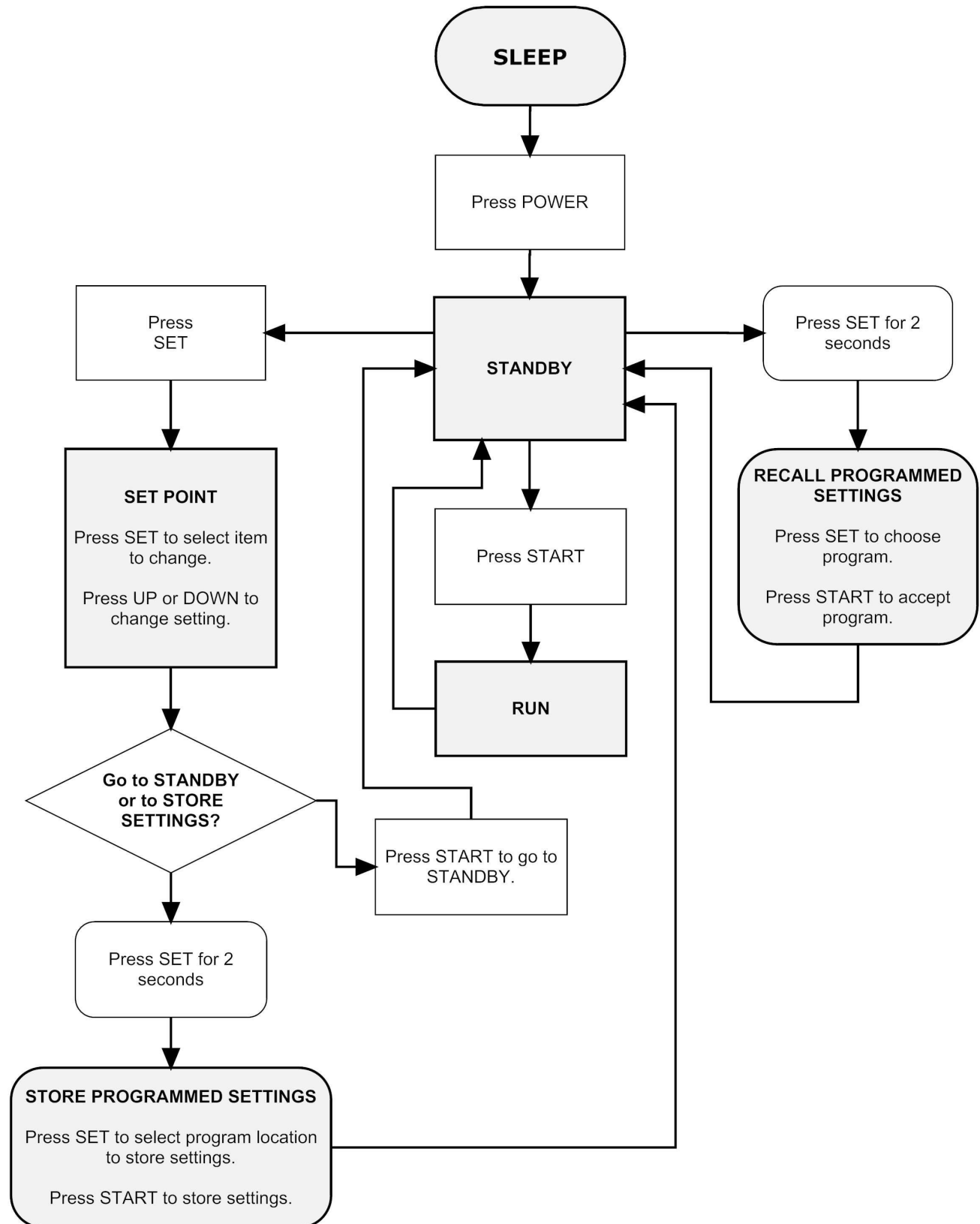


Figure 3.3

# Care Of The TANK / ROVER

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## **WARNING**

Turning the power off does not remove power to the centrifuge. Remove all power to the unit by unplugging the power cord.

## **WARNING**

Standard safety precautions for handling of biological hazards must be followed!

## **CAUTION**

Do not get any liquids into the top of the motor. Many disinfectants are extremely corrosive and may damage the motor.

## **CAUTION**

Allowing liquid levels in the rotor chamber to rise to the bottom of the motor seal may result in serious damage to the centrifuge.

## **CAUTION**

Use of disinfectants with PH >8 is not recommended.

- The rotor must be removed from the centrifuge for disinfecting. The rotor can be disinfected with PH neutral disinfectants if rinsed and dried prior to use. The disinfectant manufacturer's instructions must be followed. Do not use if the disinfectant manufacturer warns against use on aluminum, stainless steel, or neoprene.
- Clean tube breakages and spills immediately and thoroughly. The interior can be disinfected with PH neutral disinfectants. Disinfectants such as bleach can be used for the rotor chamber only. The interior must be rinsed and dried thoroughly before using the centrifuge. Use water sparingly when rinsing, as the motor seal is not watertight.
- Residue from broken tubes is highly abrasive. Operating the centrifuge with residue from broken tubes can damage the finish on the accessories and rotor chamber possibly compromising their protection from chemicals.

A white powder inside the rotor chamber is indicative of the debris from broken plastic tubes not being thoroughly removed prior to operating.

A charcoal grey residue inside the rotor chamber is indicative of the debris from broken glass tubes not being thoroughly removed prior to operating.
- The exterior should be kept clean with the use of a mild soap and a damp (not wet) lint-free cloth. The centrifuge must be dried thoroughly before using.



- The horizontal rotor and carriers must be cleaned and lubricated with the cleaner/lubricant Tri-Flow™ (see Appendix F for details):
  - ◇ when a NOTE: 201 message appears on the display
  - ◇ after cleaning or decontamination of rotor, carriers, or rotor chamber
  - ◇ after tube breakages
  - ◇ when experiencing frequent rotor imbalances at speeds below 1,000 RPM
  - ◇ when experiencing excessive vibration at speeds below 1,000 RPM
  - ◇ at least once per month (more frequent in high frequency use or high speed applications)
- The Imbalance Sensor Assembly should be tested when a NOTE: 202 message appears on the display. See Appendix G for instructions on performing this test.

## Chapter 5

# Troubleshooting

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## STATUS CODES

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This is a list of error codes and the brief description that the centrifuge displays when an error is encountered. Check under symptoms for more details.

ERROR: 1.1	Indicates no power is getting to the motor.
ERROR: 1.2	Indicative of low line voltage or a momentary sag.
ERROR: 1.3	Indicative of a momentary drop or loss of line voltage. (LOCKING)
ERROR: 3.0	Imbalance at speeds < 100 RPM. Check the imbalance sensor.
ERROR: 3.1	Dynamic imbalance: Perform the rotor cleaning and lubricating.
ERROR: 3.2	Imbalance: Ensure carriers are in the proper position and the load is balanced.
ERROR: 3.3	Tighten rotor nut and motor screws. Ensure the rotor is level.
ERROR: 7.1	Check the lid safety interlock switch for proper alignment and continuity.
ERROR: 7.2	Check the lid safety interlock switch for proper alignment and continuity.
ERROR: 7.3	Do not attempt to open the lid until the unit has stopped. (LOCKING)
ERROR: 8	Ensure the line voltage is stable & the circuit isn't overloaded.

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## ERROR RESET

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Pressing the front panel POWER button will reset most error messages.

Locking errors indicate an issue that needs to be addressed before the unit is put back into service. Unplug the centrifuge for approximately 20 seconds in order to reset locking errors.

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## TROUBLESHOOTING TABLE

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SYMPTOM	The lid remains locked and the displays are not illuminated when the POWER button is pressed.	
	POSSIBLE CAUSES	POSSIBLE SOLUTIONS
	No power to the TANK / ROVER.	Ensure the TANK / ROVER is plugged in, there is power to the receptacle, and the main power switch is on.
	The circuit breaker has tripped.	Reset the circuit breaker. If the circuit breaker trips again contact GFMD, Ltd. at 800-323-4306 for assistance.

# Troubleshooting

<b>SYMPTOM</b>	<b>Will not start when the START button is pressed and “ERROR: 7.1” is displayed.</b>	
	<b>POSSIBLE CAUSES</b>	<b>POSSIBLE SOLUTIONS</b>
	The lid safety interlock switch is defective or misaligned.	Check the lid safety interlock switch for proper alignment and continuity.
	Lid is not closed completely preventing the lid from locking.	Make sure the lid is completely closed.
	Locking mechanism is mechanically binding.	Check for proper lid lock solenoid movement.
	Lid lock safety interlock switch is defective or misaligned.	Check the lid lock safety interlock switch for proper alignment and continuity.

<b>SYMPTOM</b>	<b>Will not start when the START button is pressed and “ERROR: 1.1” is displayed.</b>	
	<b>POSSIBLE CAUSES</b>	<b>POSSIBLE SOLUTIONS</b>
	Indicates no power is getting to motor.	<p>Ensure the motor wires are securely connected to the Drive / Brake Relay Socket.</p> <p>Ensure the motor wires from the Drive / Brake Relay Socket are properly connected to BLACK1, GREEN1, and RED1 on the Power PCB.</p> <p>The Drive / Brake Relay’s drive contacts may be pitted or worn.</p> <p>The Drive / Brake Relay may be loose in the relay socket.</p>
	The motor tachometer cable is unplugged.	Ensure the motor tachometer cable is connected to MOTOR1 on the Power PCB.
	Bad Hall Effect Sensor in the motor.	See Appendix H for testing procedure.
	The power sagged so the unit did not start before the bootstrap capacitors discharged.	<p>Check electrical outlet for stable line voltage, and ensure that the circuit isn’t overloaded.</p> <p>Reset the unit by turning the main power switch off for approximately 20 seconds and then back on.</p>

# Troubleshooting

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SYMPTOM	Shuts down and a status code is displayed.	
	POSSIBLE CAUSES	POSSIBLE SOLUTIONS
	<b>ERROR: 1.2</b> - Indicative of low line voltage or a momentary sag in line voltage.	Check for a loose power cord connection to the outlet, an overloaded circuit, or line voltage below 110 VAC.
	<b>ERROR: 1.3</b> - Indicative of a momentary drop in line voltage, loss of line voltage, or low line voltage.	Reset the unit by turning the main power switch off for approximately 20 seconds and then back on.
	<b>ERROR: 3.0</b> - Indicates a rotor imbalance occurred at a speed below 100 RPM.	Check for an open imbalance switch, a bent switch actuator, a missing magnetic proximity sensor actuator, or a break in the wiring between the switch and the Control / Display PCB. See Appendix G for imbalance sensor testing and adjustment procedures.
	<b>ERROR: 3.1</b> - Indicates a rotor imbalance occurred at a speed between 100 and 900 RPM.	<p>This is normally indicative of a dynamic imbalance, which would mean the rotor and carriers need cleaning (see Chapter 4 Care Of The TANK / ROVER), or a substantially unbalanced load.</p> <p>If cleaning the rotor and carriers does not resolve the error, ensure the carriers are in the proper rotor position and the load is balanced (see Chapter 3 Using The TANK / ROVER).</p>
	<b>ERROR: 3.2</b> - Indicates a rotor imbalance occurred at a speed between 1000 and 1500 RPM.	This is indicative of a static imbalance. Ensure the carriers are in the proper rotor position and the load is balanced (see Chapter 3 Using The TANK / ROVER).
	<b>ERROR: 3.3</b> - Indicates a rotor imbalance occurred at a speed greater than 1500 RPM.	Imbalances at this speed are normally caused by the rotor not being level. Ensure the rotor retaining nut is tight, the motor mounting hardware is tight, and the counter-top is level.

# Troubleshooting

	<b>ERROR: 7.2</b> - Indicates the lid safety interlock switch failed during a run cycle or an attempt was made to open the lid during the run cycle.	<p>If there was not an attempt to open the lid before the unit came to a complete stop, see suggestions for the centrifuge not starting and giving an “ERROR: 7.1” error.</p> <p>If someone attempted to open the lid during the run cycle, please wait until the unit has come to a complete stop before opening the lid. Manually releasing the lid during the cycle creates a hazardous condition and is an OSHA safety violation.</p>
	<b>ERROR: 7.3</b> - Indicates the lid safety interlock switch failed during deceleration or an attempt was made to open the lid before the unit came to a complete stop.	<p>If there was not an attempt to open the lid before the unit came to a complete stop, see suggestions for the centrifuge not starting and giving an “ERROR: 7.1” error.</p> <p>If someone attempted to open the lid during the run cycle, please wait until the unit has come to a complete stop before opening the lid. Manually releasing the lid during the cycle creates a hazardous condition and is an OSHA safety violation.</p>
	<b>ERROR: 8</b> - Indicates the speed was too erratic.	<p>Check electrical outlet for stable line voltage, and ensure that the circuit isn’t overloaded.</p>

SYMPTOM	The sample temperature is exceeding 39°C.	
	POSSIBLE CAUSES	POSSIBLE SOLUTIONS
	The rotor chamber heat extraction fans aren’t turning on.	Verify that the fans are turning on when the cycle is started, continues to run during the cycle, and for several minutes after the rotor comes to a complete stop.
	Cycle times are too long, operating speed is too high, and /or cycles are too frequent.	Lower the operating speed (see Appendix B R.C.F. Chart for appropriate speed), shorten spin time, and/or allow more cooling time between cycles with the lid open.

# Troubleshooting

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	Centrifuge is under a heat vent.	Relocate the centrifuge away from heat vents.
	Centrifuge's immediate ambient environment is warm due to other equipment.	Relocate unit away from heat producing equipment.

## Chapter 6

# Functional Description

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The TANK / ROVER consists of the following interactive circuits:

- AC Power Distribution
- DC Power Distribution
- Operator Interface Circuits
- Imbalance Sensor Circuit
- Lid Interlock Circuit
- Lid Unlocking Circuit
- Tach Feedback Circuit
- Motor Control Circuit
- Motor Driver Temperature Sense Circuit
- Motor Current Sense Circuit
- Fan Control Circuit
- Motor Braking Circuit

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## AC POWER DISTRIBUTION

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Power for the TANK / ROVER is 115 VAC and is supplied through a CSA approved line cord with a three prong grounding plug, a power entry module, a double pole main power interrupt switch, and a 10 ampere circuit breaker to a medical version EMC filter FL1. The output of FL1 is applied to the Power PCB.

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## DC POWER DISTRIBUTION

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The Power PCB supplies unregulated HV (approximately +160 VDC), +15 VDC regulated, and +5 VDC regulated (VCC). The common for all DC power supplies is VSS.

The line voltage enters through connector ACPOWER1 pins 1 and 3, and is applied to MOV1, MOV2, MOV3, and bridge rectifier D1.

Output of bridge D1 is applied through VR1 and VR2 to filter capacitors C25 and C26, supplies unregulated HV to the motor control pulse width modulation circuitry, and to the power module PS1.

The output of PS1 provides regulated +15 VDC. The +15VDC is applied to regulator U4. U4 output is regulated +5 VDC (VCC). VCC is used by the logic circuitry on the Power PCB and is supplied to the Display / Control PCB through CONTROL1 pin 2.

# Functional Description

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## OPERATOR INTERFACE CIRCUITS

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The Display / Control PCB handles setting and visual status of power on, run activation, time, speed, and displaying error messages.

The POWER push button switch is applied to U4 pin 3 and U4 output at pin 14 is applied to U1 pin 43. This alternates the centrifuge between a low power sleep mode and standby mode. When the centrifuge is in the run mode the POWER button can also be used as a STOP button.

The START push button switch is applied to U4 pin 4 and U4 output at pin 13 is applied to U1 pin 44. The START button is used to start the run mode.

The SET push button switch is applied to U4 pin 7 and U4 output at pin 10 is applied to U1 pin 3. The SET button is used to enter the set point mode, the program store mode, the program recall mode, and to select items in those modes. See Chapter 3 for details on the SET button usage.

The UP push button switch is applied to U4 pin 5 and U4 output at pin 12 is applied to U1 pin 1. The UP button is used to increment the value of items selected with the SET button.

The DOWN push button switch is applied to U4 pin 6 and U4 output at pin 11 is applied to U1 pin 2. The DOWN button is used to decrement the value of items selected with the SET button.

## IMBALANCE SENSOR CIRCUIT

---

The imbalance sensor assembly has two switches wired in series. When both switches are closed there is continuity from Display / Control PCB connector AUX1 pin 1 to AUX1 pin 2 indicating normal operation. There is an imbalance plate positioned in front of the imbalance sensor assembly and mounted to the motor mounting assembly. Movement of this plate is relative to rotor imbalance. When there is excessive rotor imbalance this plate will activate one of the switches generating an error.

The primary sensor is a snap action switch with a roller actuator. The normally closed contact is used and the switch contacts are opened by the roller actuator being pushed in by the imbalance plate.

The secondary sensor is a magnetic proximity sensor and is normally open. The contacts are held closed by the magnetic actuator that is mounted to the imbalance plate. This sensor acts as a backup to the primary sensor and since it operates in the opposite direction it will trigger if the imbalance sensor assembly is misadjusted in an attempt to desensitize the primary sensor.

## LID INTERLOCK CIRCUIT

---

The lidlock assembly has two switches wired in series. One indicates if the lid is open or closed and the other indicates if the lock is engaged or disengaged. If either switch is open pin 2 of SAFTY1 on the Power PCB will be high. This signal is applied through pin 4 of CONTROL1 to pin 3 of U2 on the Display / Control PCB. The output of U2 at pin 14 is applied to U1 pin 10. This input is used to verify the switches status prior to starting and to generate an error if either



# Functional Description

---

switch opens after the unit starts. The pull-up resistor (R6) ensures the default status assumes the lid is open in the event the lidlock assembly is unplugged or there is a break in the circuit.

---

## LID UNLOCKING CIRCUIT

---

The default condition of the lidlock assembly is locked. Unlocking of the lid is handled by energizing a solenoid. Initially full voltage is applied to the solenoid to energize it. The unlocking voltage is controlled from pin 41 of U1 on the Display / Control PCB. This signal is applied to U2 pin 4. The output of U2 at pin 13 is supplied through CONTROL1 pin 8 to the gate of Q1. Q1 applies VSS to the solenoid.

After the lid is unlocked a lower voltage is applied to the solenoid to hold it energized and the unlocking voltage is turned off. The solenoid holding voltage is controlled from pin 9 of U1 on the Display / Control PCB. This signal is applied to U2 pin 2. The output of U2 at pin 15 is supplied through CONTROL1 pin 6 to the gate of Q2. Q2 applies VSS to the solenoid through the dropping resistor R7.

---

## TACH FEEDBACK CIRCUIT

---

There are three Hall Effect sensors in the motor. The sensor outputs are supplied to U1 on the Power PCB through MOTOR1. U1 uses this input to determine motor position and to generate an RPM output. The motor position information is used to control the three-phase motor driver U5 on the Power PCB. The RPM output is sent to the Display / Control PCB through CONTROL1 pin 3.

There are 4 pulses per revolution so RPM can be calculated by measuring duration of a tachometer pulse with an oscilloscope and applying the formula  $((1/\text{duration in seconds}) * 60) / 4$ . The speed can also be checked using a frequency counter and applying the formula  $((\text{tachometer frequency in seconds}) * 60) / 4$ .

---

## MOTOR CONTROL CIRCUIT

---

When a run cycle is started a signal from pin 12 of U1 on the Display / Control PCB is applied through CONTROL1 pin 5 to U1 pins 4 to enable the run mode.

A PWM value from U1 pin 16 on the Display / Control PCB is applied through CONTROL1 pin 10 to pin 6 of U1 on the Power PCB. The PWM pulse is at a constant frequency and a duty cycle that is adjusted based upon the TACH feedback to control motor speed.

---

## MOTOR DRIVER TEMPERATURE SENSE CIRCUIT

---

Thermistor output of the three-phase motor driver (U5) at pin 14 is inversely proportional to the temperature of U5. This voltage is applied to the temperature limit input of U1 at pin 5 through comparator U3B. This is a negative feedback loop that counteracts the PWM pulse to limit power to the motor if the driver is too warm due to inadequate heat dissipation.

# Functional Description

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## MOTOR CURRENT SENSE CIRCUIT

---

The voltage drop across sensing resistors R15, R16, and R17 on the Power PCB is proportional to the current through the drive motor. This voltage is applied to the current limit input of U1 at pins 8 and 9 through comparator U3A and inverter U2E. This is a negative feedback loop that counteracts the PWM pulse to limit current draw of the motor.

---

## FAN CONTROL CIRCUIT

---

Neutral side of FL1 output (115VAC) is applied to the fan motor (MOT2). The high side is supplied to Q1 on the Display / Control PCB through pin 1 of connector FAN1. The fan control signal is from U1 pin 34 to input of U6 at pin 2. The output of U6 at pin 4 is applied to Q1. The output of the Q1 is applied through FAN1 pin 3 to the fan motor (MOT2).

---

## MOTOR BRAKING CIRCUIT

---

After the end of the cycle U1 pins 12 and 13 on the Display / Control PCB go low turning off the run mode and the Drive / Brake Relay. Turning off the Drive / Brake Relay connects the three brake resistors to the motor through the Drive / Brake Relay's normally closed (NC) and common (COM) contacts.

When the Drive / Brake Relay turns off, the kinetic energy stored in the spinning rotor is converted to electrical energy by the motor. This voltage is applied to the brake resistors through the relay contacts. The load supplied by the brake resistors dissipates the stored energy.

The speed at which the brake turns on depends upon the brake level setting. The brake will engage immediately when an error occurs.

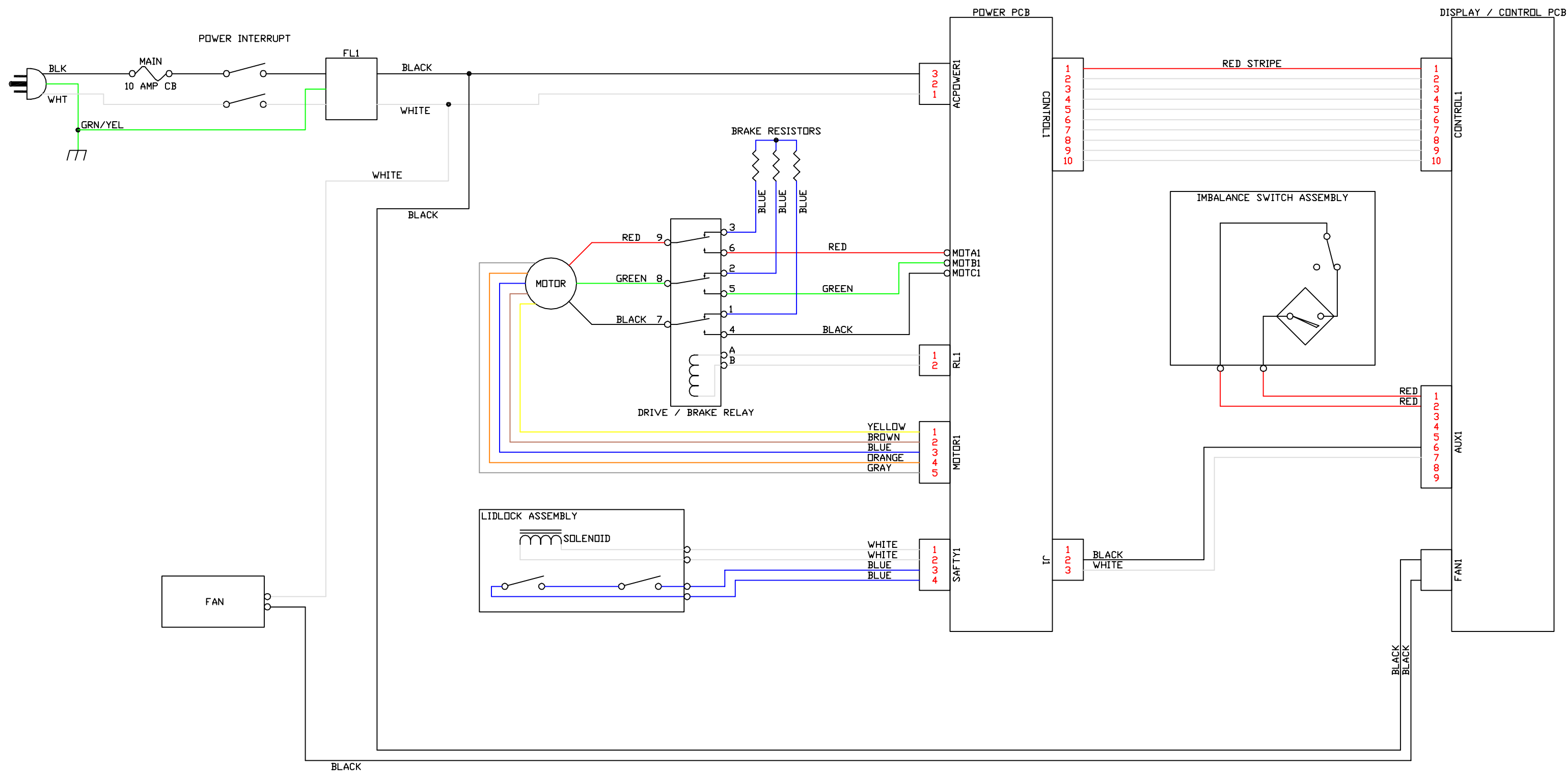


Figure 7.1  
Wiring Diagram



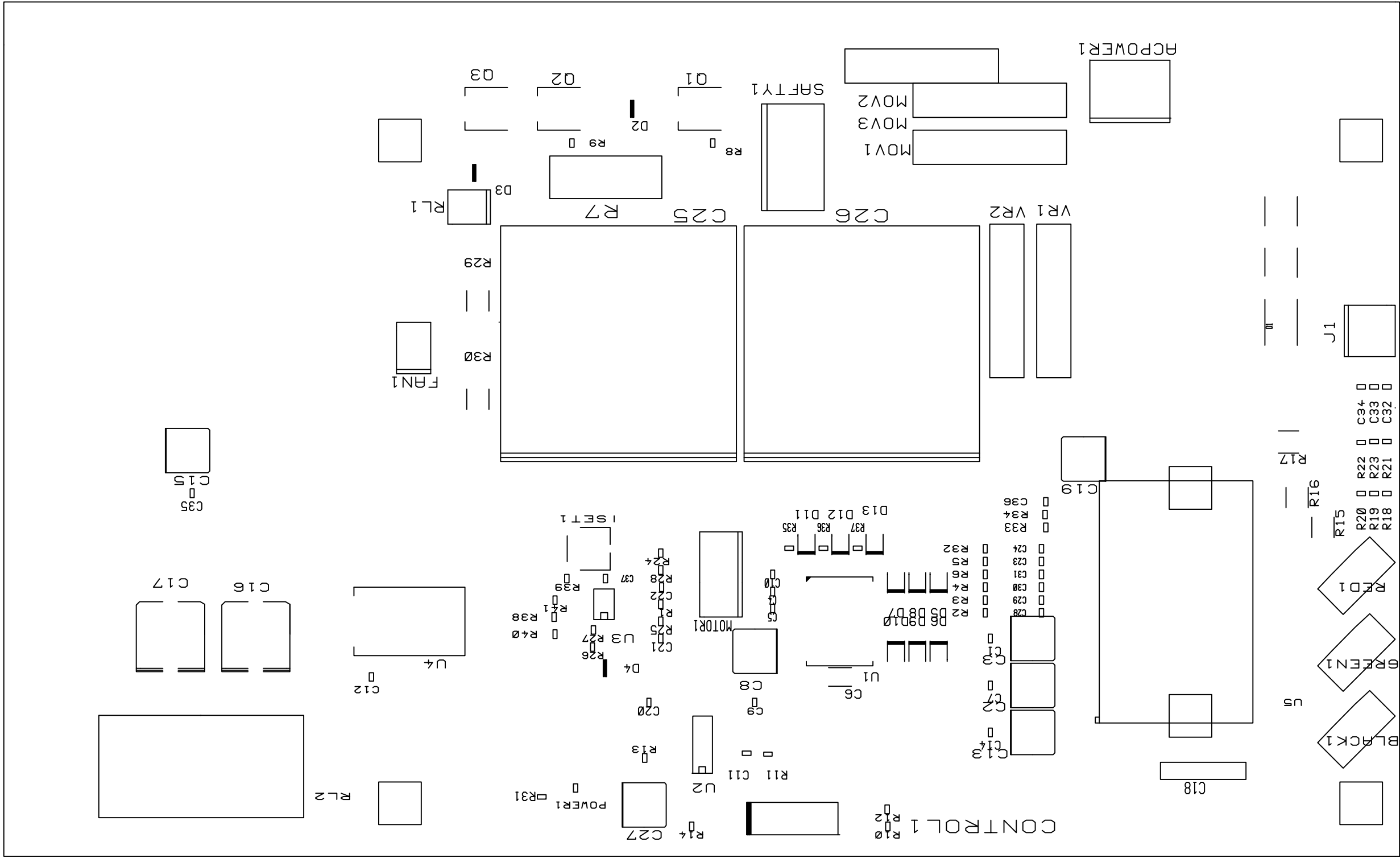


Figure 7.3  
Power P.C.B. Layout

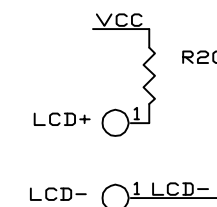
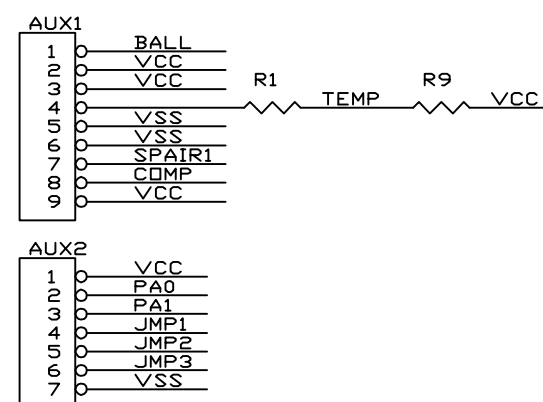
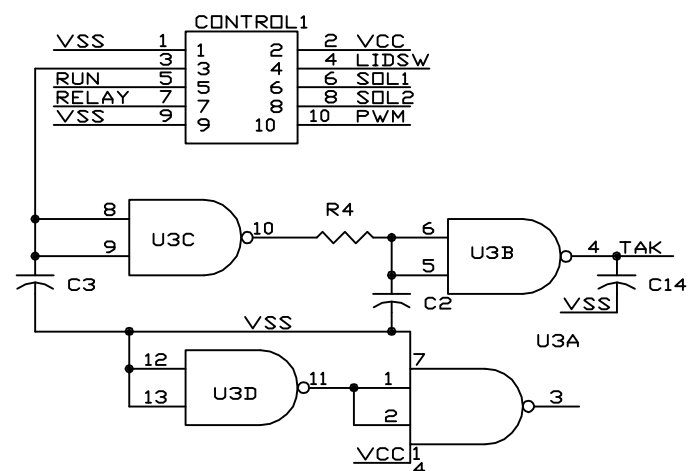
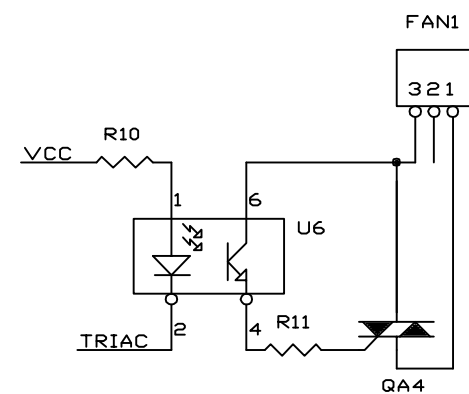


Figure 7.4  
Display / Control P.C.B. Schematic  
Page 7-4

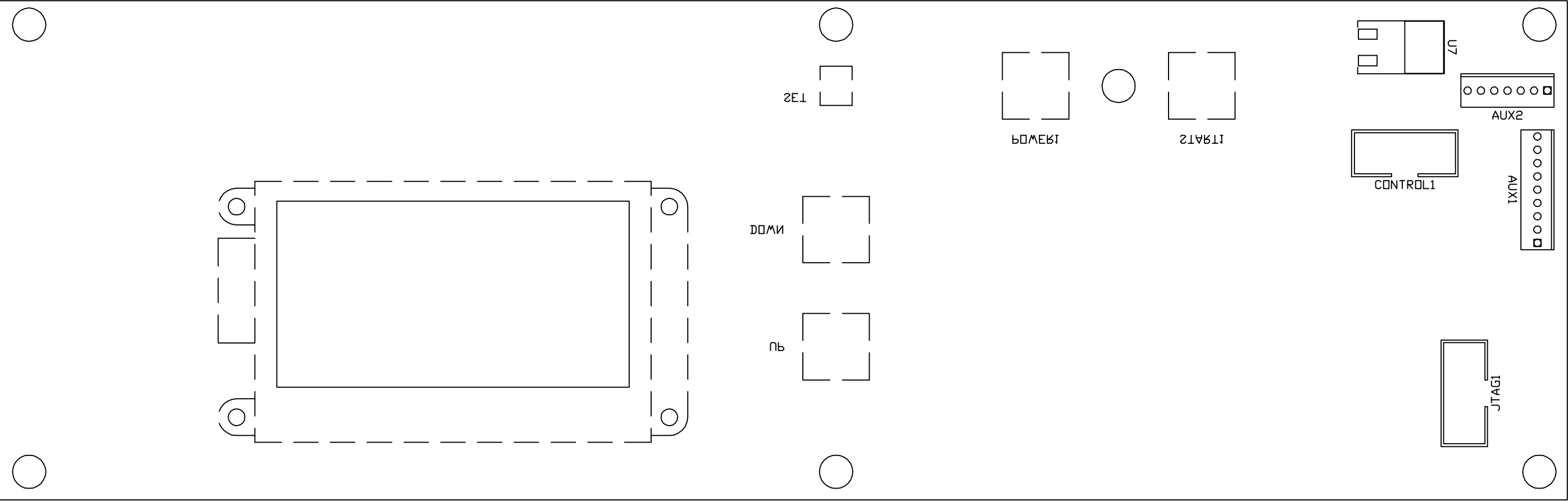
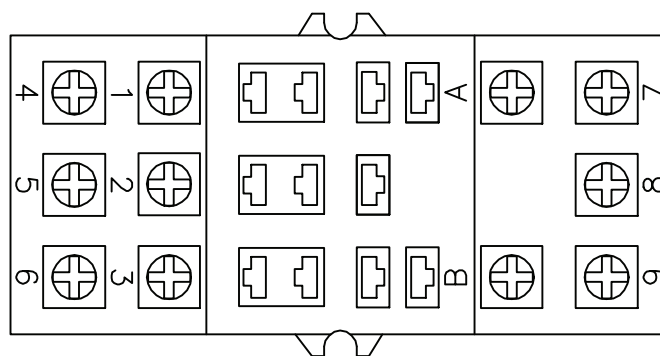


Figure 7.5  
Display / Control P.C.B. Layout  
Page 7-5



A	(COIL)	=	WHITE	-	POWER PCB (RL1)
B	(COIL)	=	WHITE	-	POWER PCB (RL1)
1	(NC)	=	BLUE	-	BRAKE RESISTOR
2	(NC)	=	BLUE	-	BRAKE RESISTOR
3	(NC)	=	BLUE	-	BRAKE RESISTOR
4	(NO)	=	BLACK	-	POWER PCB (MOTC1)
5	(NO)	=	GREEN	-	POWER PCB (MOTB1)
6	(NO)	=	RED	-	POWER PCB (MOTA1)
7	(COM)	=	BLACK	-	MOTOR
8	(COM)	=	GREEN	-	MOTOR
9	(COM)	=	RED	-	MOTOR



## Chapter 8

# Parts Replacement Procedures

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## PRECAUTIONS

---

This section describes procedures for replacement of parts which may not be obvious to complete. **Remove power and read the entire procedure carefully prior to beginning any procedure! Pay particular heed to all WARNINGS and CAUTIONS.**



## WARNING

Turning the power off does not remove power to the centrifuge. Remove all power to the unit by unplugging the power cord.

---

## EQUIPMENT

---

The following equipment is useful or necessary in the repair of the TANK / ROVER centrifuge.

- A Test Equipment
  - 1. Tachometer
  - 2. Multimeter
  - 3. Ammeter (capacity to 10 amps)
- B. Tools
  - 1. Screwdrivers (assorted slotted and Phillips)
  - 2. Nut Drivers (5/16" minimum requirement)
  - 3. Hex (Allen) Wrenches
  - 4. Adjustable Wrench

---

## MOTOR

---

Turn on power to the TANK / ROVER. Open the lid, turn the power off, and **unplug the power cord.**

Remove the four Phillips front panel retaining screws (see Figure 8.1) taking care not to drop the front panel. Lower the front panel.

Unplug the motor and tach sensor connectors.

Remove the rotor retaining nut, and gently lift the rotor off.

## CAUTION

Take care not to drop anything onto the PCB's or into the unit to prevent possible damage to the unit.

# Parts Replacement Procedures

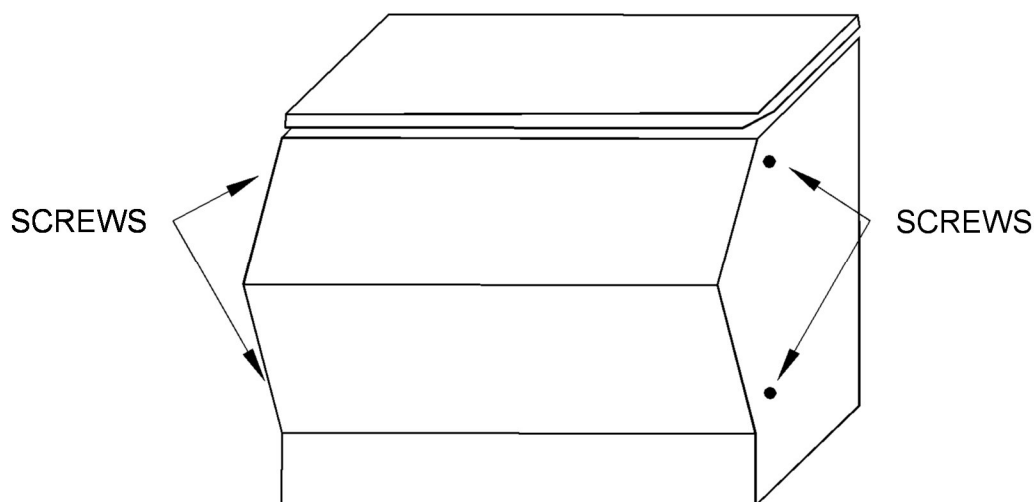


Figure 8.1

Remove the rubber motor gasket by rolling the outer edge back, unhook it from the rotor chamber (see Figure 8.2), and then pull it from around the motor.

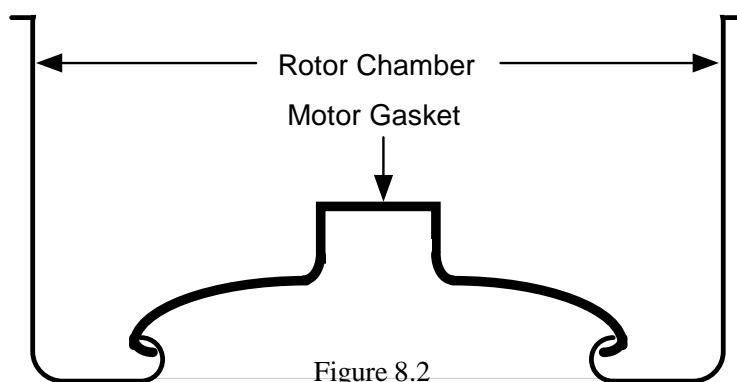


Figure 8.2

Remove the four phillips head screws from the motor mount (see Figure 8.3), and remove the motor assembly.

Reverse procedure to re-install the motor.

Lightly grease the motor shaft before reinstalling the rotor.

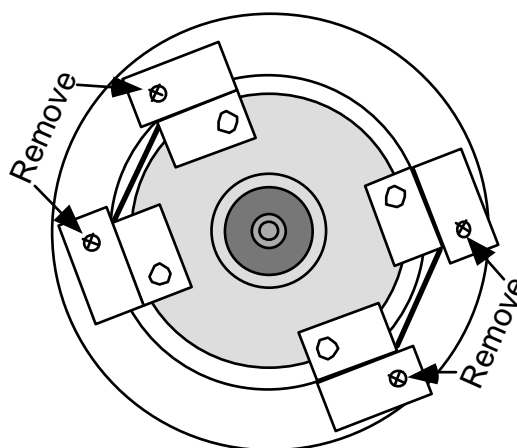


Figure 8.3

## CAUTION

Take care not to drop anything onto the PCB's or into the unit to prevent possible damage to the unit.

# Parts Replacement Procedures

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## DISPLAY / CONTROL PCB

---

**Unplug the power cord.**

Remove the four Phillips front panel retaining screws (see Figure 8.1) taking care not to drop the control panel. Lower the control panel.

Remove all plug connections, and mounting screws.

Remove the Display / Control P.C.B.

Install replacement Display / Control P.C.B. by reversing the removal procedure.

## POWER PCB

---

**Unplug the power cord.**

Remove the four Phillips front panel retaining screws (see Figure 8.1) taking care not to drop the control panel. Lower the control panel.

Remove all plug connections, and mounting screws.

Remove the Power P.C.B.

Install replacement Power P.C.B. by reversing the removal procedure.

## IMBALANCE SENSOR ASSEMBLY

---

**Unplug the power cord.**

Remove the four Phillips front panel retaining screws (see Figure 8.1) taking care not to drop the control panel. Lower the control panel.

The Imbalance Sensor Assembly is mounted in the base of the front spring support. You can find it by following the two red wires coming from the Display / Control PCB connector AUX1 pins 1 and 2.

Unplug the two pin Molex connector coming from the Display / Control PCB to the Imbalance Sensor Assembly.

Remove the Imbalance Sensor Assembly by removing the #6 hex nut and flat washer on the left side of the front spring support using a 5/16" wrench or nut driver.

Install the replacement Imbalance Sensor Assembly with the front edge of the assembly aligned with the front edge of the spring support. Secure the imbalance assembly using the #6 flat washer and #6 hex nut using a nut driver or "ignition wrench". **Do not use a ratchet wrench and do not over tighten!** The roller on the switch actuator should be touching the rubber pad

## CAUTION

Take care not to drop anything onto the PCB's or into the unit to prevent possible damage to the unit.

# Parts Replacement Procedures

---

on the back of the actuator plate, but the switch should not be activated. Reconnect the two pin Molex connector.

Test the sensitivity by running the Imbalance Sensor Testing Procedure in Appendix G. If adjustment is required loosen the #6 hex nut and move the assembly slightly. Moving the assembly towards the motor decreases the primary sensor sensitivity and increases the secondary imbalance sensor sensitivity. Moving the assembly away from the motor has the opposite effect. There is a range in the middle where the imbalance sensor is the least sensitive. If a position can not be obtained that passes the Imbalance Sensor Testing Procedure it may be necessary to test the balance of the rotor, carriers, and tube holders.

---

## LIDLOCK ASSEMBLY

---

**Unplug the power cord.**

Remove the four Phillips front panel retaining screws (see Figure 8.1) taking care not to drop the control panel. Lower the control panel.

Unplug the connector to the Lidlock Assembly.

Remove the two 5/16" hex nuts securing the Lidlock Assembly.

Install replacement Lidlock Assembly by reversing the removal procedure.

---

## DRIVE / BRAKE RELAY

---

**Unplug the power cord.**

Remove the four Phillips front panel retaining screws (see Figure 8.1) taking care not to drop the control panel. Lower the control panel.

Unplug the relay from the socket.

Plug new relay into the socket.

---

## DRIVE / BRAKE RELAY SOCKET

---

**Unplug the power cord.**

Remove the four Phillips front panel retaining screws (see Figure 8.1) taking care not to drop the control panel. Lower the control panel.

Unplug the relay from the socket.

Disconnect the eleven wires connected to the relay socket, noting which wire attaches to which screw terminal.

## CAUTION

Take care not to drop anything onto the PCB's or into the unit to prevent possible damage to the unit.

# Parts Replacement Procedures

---

Remove the two Phillips screws securing the relay socket to the base of the centrifuge, noting the orientation of the socket.

Attach the new relay socket to the base of the centrifuge with the two Phillips screws oriented the same way as the original socket.

Attach the eleven wires to the new relay socket in same positions as they were removed from the original socket. Please see Figure 7.6 for wiring orientation.

Plug the relay into the socket.

## CAUTION

Connecting the wires to the wrong screw terminal can seriously damage your centrifuge.

## CAUTION

Take care not to drop anything onto the PCB's or into the unit to prevent possible damage to the unit.

## Chapter 9

# Limited Warranty Statement

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New Silencer® centrifuges are warranted to be free from defects in material and workmanship for a period of one year from the date of delivery. GFMD, Ltd., or its agent, will repair or replace and return free of charge any part that is returned, transportation prepaid by user, to GFMD, Ltd., or its agent, within said period, and that is found upon inspection to have been defective in materials or workmanship.

There is an additional one year warranty on parts plus an additional three years on the motor. During this period GFMD, Ltd., or its agent, will repair or replace and return free of charge any part that is returned, transportation prepaid by user, to GFMD, Ltd., or its agent, within said period, and that is found upon inspection to have been defective in materials or workmanship. Labor is not included during this period.

These warranties do not include normal wear from use, or operator maintenance. It does not apply to any instrument or part that has been altered by anyone other than an employee of the manufacturer or its agent nor to any instrument that has been damaged through accident, negligence, failure to follow operating instructions, natural disaster, the use of electric currents of circuits other than those specified on the plate affixed to the instrument, insufficient or excessive electrical supply, operation on emergency or backup generators, abnormal mechanical or environmental conditions, misuse or abuse.

GFMD, Ltd. 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 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 or furnishing of goods or parts, their design, suitability for use, installation or operation. GFMD, Ltd., or its agent, 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 that liability is claimed.

## Appendix A

# Specifications

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### PERFORMANCE SPECIFICATIONS

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- Maximum speed
  - TANK / ROVER w/ Horizontal rotor 4,000 RPM
  - TANK-MP w/ Microplate rotor 3,000 RPM
- Maximum RCF
  - TANK / ROVER w/ Horizontal rotor 3,200 x g
  - TANK-MP w/ Microplate rotor 1,328 x g
- Approximate acceleration rate (0 – 4,000 RPM):
  - TANK / ROVER w/ Horizontal rotor 60 seconds
- Approximate deceleration rate (4,000 - 0 RPM):
  - TANK / ROVER w/ Brake on 60 seconds
  - Brake off 360 seconds
- Maximum noise level
  - Horizontal rotor 58 dBA
- Speed Control
  - +/- 2%
- Timer
  - +/- 5%
- Power requirements
  - 115 volts, 10 amperes

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## UNIT SPECIFICATIONS

---

- Dimensions:      TANK      19.25"W x 21.50"D x 14.38"H  
                         ROVER      19.25"W x 21.50"D x 30.13"H
- Spill resistant control panel
- Completely enclosed rotor chamber
- High-strength alloy rotor chamber
- See-through high-strength lid
- Gas piston lid support
- Dual safety interlock to ensure lid is closed and locked
- Rotor imbalance protection
- Direct drive system
- Brushless D.C. motor (1 HP)
- Microprocessor control
- Digital speed display
- Digital R.C.F. display
- Digital time display
- Timer range 1 - 999 plus hold
- Variable automatic dynamic braking system
- Biohazard containment option is easily added



## Appendix B

# R.C.F. Chart

<b>RELATIVE CENTRIFUGAL FORCE CHART</b>		
<b>RPM</b>	<b>R.C.F.</b>	
	<b>TANK / ROVER Horizontal Rotor</b>	<b>TANK-MP Microplate Rotor</b>
500	50	37
600	72	53
700	98	72
800	128	94
900	162	119
1,000	200	148
1,100	242	178
1,200	288	212
1,300	338	249
1,400	392	289
1,500	450	332
1,600	512	378
1,700	578	426
1,800	648	478
1,900	722	532
2,000	800	590
2,100	882	650
2,200	968	714
2,300	1,058	780
2,400	1,152	850
2,500	1,250	922
2,600	1,352	997
2,700	1,458	1,075
2,800	1,568	1,156
2,900	1,682	1,240
3,000	1,800	1,328
3,100	1,922	
3,200	2,048	
3,300	2,178	
3,400	2,312	
3,500	2,450	
3,600	2,592	

## RELATIVE CENTRIFUGAL FORCE CHART

RPM	R.C.F.	
	TANK / ROVER Horizontal Rotor	TANK-MP Microplate Rotor
3,700	2,738	
3,800	2,888	
3,900	3,042	
4,000	3,200	

# Service Log

[illegible]

## Appendix D

# Replacement Parts List

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<b>Description</b>	<b>Qty Needed</b>	<b>Part No.</b>
Tri-Flow™, 2 oz, Non-Aerosol	1 ea.	SIL00181
Gasket, Lid	1 ea.	SIL00451
Gasket, Motor	1 ea.	SIL00456A
Hinge, Lid	2 ea.	SIL00510
Latch, Lidlock	1 ea.	SIL00643B
Lid	1 ea.	SIL00668B
Lidlock Assembly	1 ea.	SIL00671B
Solenoid (part of SIL00671B)	1 ea.	SIL00131
Switch, Lid Interlock (part of SIL00671B)	1 ea.	SIL02456
Switch, Lock Interlock (part of SIL00671B)	1 ea.	SIL02457
Motor Assembly	1 ea.	SIL00757B
PCB, Display/Control TANK / ROVER	1 ea.	SIL00816C
PCB, Power TANK / ROVER	1 ea.	SIL00842
Relay, Drive / Brake	1 ea.	SIL01103
Brake Resistor Assembly	1 ea.	SIL01216
Rotor Chamber	1 ea.	SIL00497
Switch, Imbalance	1 ea.	SIL02441

Parts are sold individually. The quantity listed is the quantity used per unit.

# Lid Release Tool

---



## WARNING

The lid release tool is provided for emergency access to samples only. Unplug the centrifuge before attempting this procedure!

The correct tool must be used for your unit or the lid safety interlock switch may become damaged. If the interlock switch is damaged the unit can't detect the lid being closed and therefore won't start.

To use the release tool:

1. Unplug the centrifuge.
2. Insert the tool completely into the release access port on the left side of the unit (just below the lid locking bracket).
3. Push the handle towards the back of the unit and lift the centrifuge lid.

# Care of Rotor & Accessories

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### **WARNING**

Follow standard safety precautions for handling of potential biological hazards!

Proper rotor / carrier care is required on horizontal rotors to maintain smooth performance and to minimize rotor imbalances caused by dynamic carrier imbalances. The frequency it is required is dependent upon variables such as workload, tube breakages, and cleaning / disinfecting frequency. This procedure should be performed after any tube breakage (after all glass has been removed and the rotor chamber has been cleaned), and after any cleaning or disinfecting of the carriers or the rotor chamber is performed. If there is a procedure calling for scheduled cleaning and/or disinfecting, please add this procedure as the last step of that procedure.

---

## MATERIALS REQUIRED

---

1. Tri-Flow® cleaner / lubricant (available as GFMD, Ltd. cat. no. SIL00181)
2. Cotton Swabs
3. Rubber Gloves

---

## CLEANING & LUBRICATING PROCEDURE

---

1. Ensure all the carriers (buckets) have the same serial number. The serial number will be on the outside bottom of the carrier.
2. Ensure the carriers are in their correct rotor position. The rotor position number will be on the outside bottom of the carrier.
3. Starting with rotor position 1.
4. Remove the insert (tube holder) from the carrier and set aside.
5. Remove the carrier from the rotor.
6. Ensure there is no debris or residue from broken tubes in the carriers that may affect balance.
7. Set the carrier upside down on a convenient work surface.
8. Shake the Tri-Flow® well and apply a small amount into the recessed area on one side of the carrier.

# CARE OF ROTOR & ACCESSORIES

9. Clean the recessed area out using a cotton swab.
10. Repeat steps 8 & 9 using fresh cotton swabs until the swabs do not show any gray/black residue after use. Leave a film of lubricant when finished.
11. Perform steps 8 - 10 on the recessed area on the other side of the metal carrier.
12. Shake the Tri-Flow<sup>®</sup> well and apply a small amount to a fresh cotton swab and clean the rotor pivot pins by wiping with the cotton swab.
13. Repeat step 12 with fresh cotton swabs as necessary to thoroughly clean the rotor pins. Leave a film of lubricant when finished.
14. Replace the carrier onto its rotor position.
15. Ensure there is no debris or residue from broken tubes in the insert that may affect balance.
16. Replace the insert into its carrier.
17. Perform steps 4 - 16 on rotor positions 2 - 4.
18. Ensure that the opposite inserts are of the same type, balanced, and oriented the same.

## Appendix G

# Imbalance Sensor Assembly Testing



## WARNING

Follow standard safety precautions for handling of potential biological hazards!

The cleaning and lubricating procedure in Appendix F must be performed prior to performing this test for the test to be valid.

## MATERIALS REQUIRED

1. Four 10ml (16mm x 100mm) Tubes or six 7ml (13mm x 100mm) Tubes.
2. Personal Protection Equipment as specified by OSHA regulations.

## IMBALANCE SENSOR TESTING PROCEDURE

1. Ensure all the carriers (buckets) have the same serial number. The serial number will be on the outside bottom of the carrier.
2. Ensure the carriers are in their correct rotor position. The rotor position number will be on the outside bottom of the carrier.
3. Ensure that the opposite inserts are of the same type, balanced, and oriented the same.
4. Ensure the carriers are pivoting smoothly. Test them by pressing down on the outer edge of each carrier and releasing. The carriers should swing a few times and end with the carrier vertical. If the carriers are not swinging smoothly contact GFMD, Ltd. at 800-323-4306 before proceeding.
5. Set the speed for 3,000 RPM.
6. Load two empty 10ml tubes opposite two 10ml tubes with 10ml of water in each creating a 20 gram imbalance. If using 7ml tubes load three empty tubes opposite three 7ml tubes with 7ml of water in each creating a 21 gram imbalance.
7. Press START. The unit should shut down and give an imbalance error prior to reaching a speed of 1,000 RPM. If the speed exceeds 1,000 RPM stop the unit by pressing START again.
8. If the unit shuts down with an imbalance error the test is complete. Remember to remove all tubes before returning to service.
9. If the unit did not shutdown with an imbalance error increase the imbalance by adding one more empty tube opposite one more full tube to increase the imbalance.

If the unit failed the imbalance sensor test proceed with the Imbalance Sensor Adjustment Procedure.

**Do NOT put the unit back into service until the imbalance sensor is functioning properly!**



---

## IMBALANCE SENSOR ADJUSTMENT PROCEDURE

---

1. The imbalance sensor assembly has two switches wired in series. When both switches are closed the signal between AUX1 pin 1 and AUX1 pin 2 on the Display / Control PCB (two red wires) will be < 1VDC. There is an imbalance plate positioned in front of the imbalance sensor assembly and mounted to the motor mounting assembly. Movement of this plate is relative to rotor imbalance. When there is excessive rotor imbalance this plate will activate one of the switches causing the circuit to open and generate an error.
2. The primary sensor is a snap action switch with a roller actuator (see red circle in Figure G.1). The normally closed contact is used and the switch contacts are opened by the roller actuator being pushed in by the imbalance plate.
3. The secondary sensor is a magnetic proximity sensor and is normally open. The contacts are held closed by the magnetic actuator that is mounted to the imbalance plate. This sensor acts as a backup to the primary sensor and since it operates in the opposite direction it will trigger if the imbalance sensor assembly is misadjusted in an attempt to desensitize the primary sensor.
4. The imbalance plate should be at roughly a 90 degree angle from the plate that it is mounted to. If the imbalance plate is bent in or out it will need to be reshaped prior to adjustment of the assembly.
5. If the plate is bent in at the bottom the plate can be adjusted by pulling out on the bottom.
6. If the plate is bent out at the bottom the plate can be adjusted by holding the top while pushing in on the bottom (see Figure G.2). Leverage can be gained by the use of a screwdriver (see Figure G.3) while pushing in on the bottom.
7. Once the imbalance plate is at the correct angle the imbalance sensor assembly can be adjusted. This is done by loosening the assembly mounting nut (see blue circle in Figure G.1) and sliding the assembly. The roller actuator (see red circle in Figure G.1) should be set so that it is just touching the rubber pad attached to the back of the imbalance plate.
8. Rerun the Imbalance Sensor Testing Procedure and repeat step 7 if necessary.

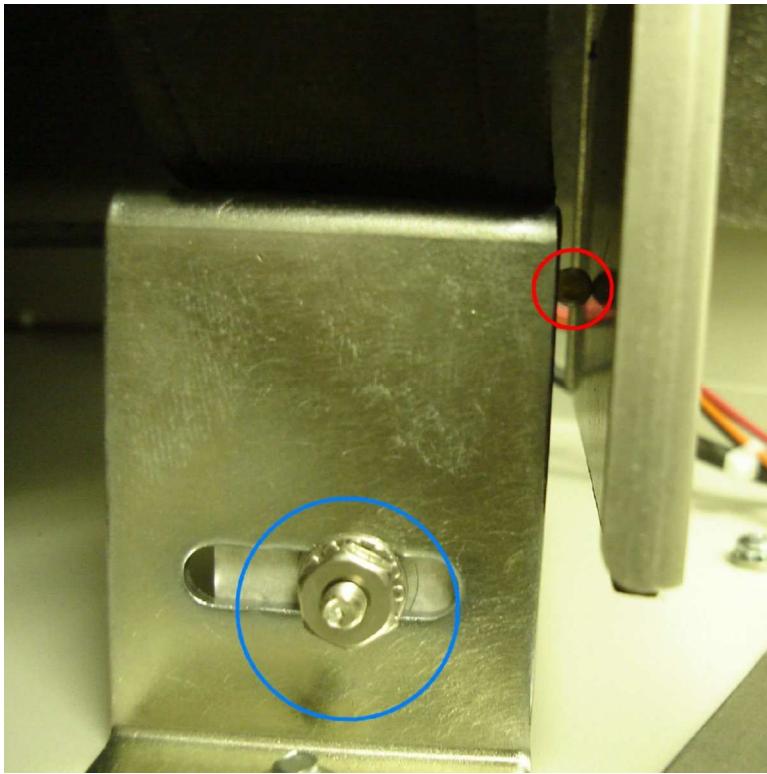


Figure G.1

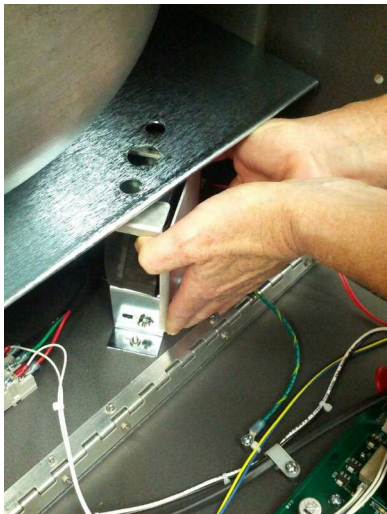


Figure G.2

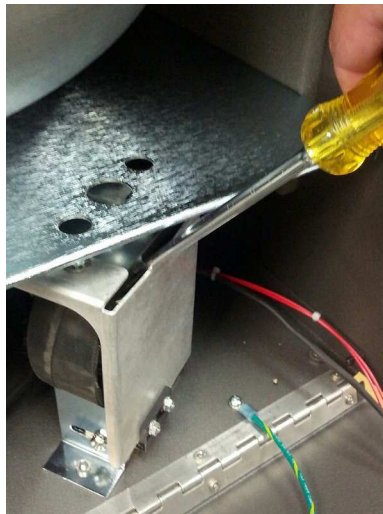


Figure G.3

# Motor Hall Effect Sensor Testing



**WARNING**

Follow standard safety precautions for handling of potential biological hazards!

The motor has three Hall effect sensors that are used for angular position information to determine which phase needs to be energized. Hall effect sensor A is also tach feedback for speed control. Some models do not have the DRIVE / BRAKE RELAY and the BRAKE RESISTORS but the Hall effect sensor testing is the same.

1. MOTOR1 pin 1 (yellow) is VCC (+5 VDC).
2. MOTOR1 pin 5 (gray) is VSS (common).
3. Measure the DC voltage from VSS to MOTOR1 pin 2 (brown) while slowly turning the rotor by hand.
4. The voltage should switch between high and low ( $> 4$  VDC and  $< 1$  VDC).
5. Repeat steps 3 and 4 for MOTOR1 pin 3 (blue) and MOTOR1 pin 4 (orange).

