Part Number 679054
Rev. AA

ALLEGRA 6 SERIES
SPINCHRON R

Service Manual

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SAFETY REMINDERS

The following pages summarize cautionary information basic to the safe operation of this instrument. However, it is strongly recommended that the user read the entire manual carefully before attempting to service the instrument. In addition, be sure to heed all **NOTES, CAUTIONS**, and **WARNINGS**, which are specifically defined as follows:

NOTE: Used to make a procedure easier or clearer. To disregard it may cause inconvenience, but not mechanical damage or personal injury.

CAUTION: Used to prevent equipment damage. To disregard the caution may cause mechanical damage, however, personal injury is not likely.

WARNING: Used whenever an action or circumstance may potentially cause personal injury or loss of life. Mechanical damage may also result.

RELATED DOCUMENTS

This Service Manual does not include the Instruction Manual for this instrument. The Instruction Manual contains instructions for proper operation of the instrument, information regarding the limitations, specifications, precautions and hazards associated with its use.

To obtain a copy of the Instruction Manual, please order it through any Beckman Sales and Service Office.

Part Number	Description
BE-IM-1	Allegra 6 Instruction Manual

IMPORTANT NOTICE

This Service Manual is designed solely for the use of Beckman Field Service Representatives who have and training and experience in the servicing of Beckman products. To improve product performance, Beckman may have made changes in the product to which this Service Manual relates. Such changes may not be reflect in this manual. Accordingly, Beckman makes no representation or warranty, either express or implied, that the information contained in this Service Manual is complete or accurate with respect to the particular product to which this manual pertains, and the purchaser must assume all risks in the use of this manual for the purpose of performing service upon such product.

Because of the possible hazards involved to an inexperienced person in servicing the product, Beckman recommends that servicing of your product be performed only by Beckman Field Service Representatives.

Components of this instrument which are considered user serviceable are discussed in detail in the instrument's instruction manual.

MECHANICAL SAFETY

Good mechanical safety practices are more important than ever now that microprocessors are taking control of mechanical devices. Yet, the area of mechanical safety is often overlooked during instrument servicing. We maybe able to change this situation if you heed the following safety tips:

- Remember to keep clothing and fingers away from rotating or moving components. It is easy to slip, lose a tie, or get cut while working near one of these devices.

- Unless it is absolutely essential, never run mechanical components without the protective guards in place.

- Always use the tools specifically recommended for the job. This not only reduces the chances of injury, it minimizes damage to the instrument.

- Although not always possible, it is recommended that mechanical devices be adjusted or calibrated with the power turned **OFF**. This is especially important if you are working with a microprocessor-controlled instrument, which can start running without notice or user intervention.

- After the mechanical repairs have been completed, always check that all mounting hardware and safety shields are in place and secure. By doing so, you will not only ensure safe operation of the instrument, but may reduce callbacks.

As you can appreciate, all it takes is good common sense, plus good safety techniques that are basic and easy to remember. With this is mind, you should have no trouble servicing mechanical devices safely.

ELECTRICAL SAFETY

It is shocking but true. Many people service instruments without giving much thought to electrical safety. Unfortunately, this can be a dangerous mistake. As electrical/electronic devices are used more widely in modern instrumentation, it means that you may be exposed to more potential shock hazards.

It pays to take a few precautions before and during servicing to avoid injury from electrical shock. Here are a few safety tips that can help keep you on the job without a sudden vacation:

- Avoid standing on damp floors! People have been shocked simply by standing on a wet floor and then working on live equipment.

- Be sure to disconnect the power cord before working on any high voltage circuitry! As power switches disappear from new equipment, this precaution is very easy to overlook.

- Read and heed **ALL** caution labels! They are posted for **YOUR** safety.

- Take care of test equipment. Be sure to use the right probes for the right job. Measuring high voltages, for example, requires a well-insulated, high voltage probe. Damaged probes and cables are dangerous and should not be used. Also, be cautious around test equipment like an oscilloscope. The oscilloscope case may become live if you connect the cable ground to a live circuit. Avoid this dangerous situation at all times!

- Always treat cathode ray tubes (CRTs) and uncased photomultiplier tubes (PMTs) with special care. When carrying them, wear eyeglasses and protective gloves. If these devices are dropped or struck with a sharp object, they can implode violently and scatter glass.

These basic tips regarding good electrical safety practices are easy to remember. Combined with good common sense, they should keep you on the job for a long time to come.

ELECTROSTATIC DISCHARGE

Static electricity is an electrical charge which can damage circuitry and components Listed below are important **E**lectro**S**tatic **D**ischarge guidelines for handling electronic components. Following these guidelines will avoid needless damage to circuit cards and components on them.

- Keep paper, non-conductive plastic, plastic foams or cardboard away from circuit boards and components and static free work areas.
- Keep hand creams and food away from the conductive work surfaces. If spilled on the bench top, these materials contaminate and increase the resistivity of the work area.
- Be especially careful when using soldering guns around conductive work surfaces. Solder spills and heat from the gun may melt and damage the conductive mat.

- Check the grounding connections on wrist strap and static mats. (Mat must have proper ground.) Make certain they fit snugly before starting work with the components and printed circuit cards.

- Touch the conductive work surfaces before starting work.

- Know the ESD caution symbols.

- Do not allow anyone not grounded to touch ESD sensitive components in the work area. To be grounded, they must be standing on the conductive floor mat and must touch the conductive bench top mat before touching the components or printed circuit cards.

- Do not place ESD sensitive components on work areas that are not grounded properly.

- Do not touch the component by the pins or leads since the most damage is done at these points by ESD. Handle the components by the cap edges or body and the printed circuit cards by the edges.

- Do not handle components or printed circuit cards during transport between work stations. Components or cards must not be directly handled by anyone not grounded.

- Do not use Refrigerant or other chlorinated cleaners at the work area. Use conductive or anti-static bags and containers for storage and transportation of components or circuit boards.

REFRIGERATION SYSTEM SAFETY

Working with refrigeration systems requires special equipment and training. If you are not familiar with the operational theory for refrigeration systems and the special requirements for performing service on a system, do **NOT** attempt it. Use the following precautions for working with refrigeration systems in Beckman instruments.

- Always use protective glasses and clothing.
- Do **NOT** inhale refrigerant. It has an intoxicating effect and is harmful to your health.
- Refrigerant can easily cause "frostbite". Be especially careful with liquid refrigerant.
- Use caution when replacing a burnt out compressor. The oil in the compressor may be very caustic or acidic. Use protective gloves.
- Charge refrigeration systems with gas from the low side only. High side charging may damage the compressor.
- Do **NOT** run a compressor without refrigerant in the system. Compressors are cooled by the refrigerant and will burn out if there is no cooling.

BRAZING SAFETY PRECAUTIONS

Brazing requires the use of a high-temperature "MAPP Gas" torch and as such many potential safety hazards exist. Always follow the guidelines below when brazing.

- Wear safety glasses.
- Work in a ventilated area.
- Know fire extinguisher location.
- Heat sink, shield components.
- All refrigerant removed from the system (no pressure).
- Do not invert turbo-torch (flame-thrower).
- Fit and brace parts.
- Check to see if smoke detectors are present--move your operation.
- Always insure that heated parts have cooled completely before handling them.

WARNING: Sound, wire, and thermal insulation materials may produce dangerous gases when heated or burned. Use caution when brazing in areas where these and other materials are present

Safety Reminder

Centrifuges are not designed for use with materials capable of developing flammable or explosive vapors. Such materials should not be handled or stored near the instrument.

- Spills may generate aerosols. Pathogenic, toxic, or radioactive materials should not be used in this instrument unless all necessary safety precautions are taken.

- Maintenances other than that contained in this manual should be performed only by trained, qualified personnel.

- Turn the **POWER off** and disconnect the instrument from the main power source before performing any maintenance that requires the removal of an instrument panel.

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

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

Part Number 679054
Rev. AA

ALLEGRA 6 SERIES
& SPINCHRON R

Main Table of Contents

SECTION 1

INTRODUCTION

1.1 Performance Specification

1.1.1 Allegra 6 Specifications

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

Speed	
Set (in 200-rpm increments)	0 to 8000 rpm
Display	±30 rpm of actual
Set time	
Timed run	up to 30 min
Continuous run	HOLD ( )
Temperature	
Temperature setting (refrigerated models only)	not applicable
Normal operating range (refrigerated models only)	not applicable
Temperature display (refrigerated models only)	not applicable
Ambient temperature range	10 to 35°C
Ambient temperature range for optimum operation	10 to 25°C
Humidity restrictions	<95% (noncondensing)
Dimensions	
Width	54.6 cm (21.5 in.)
Depth (overall)	66.0 cm (26.0 in.)
Depth (at base)	58 cm (23 in.)
Height, door closed	40.6 cm (16.0 in.)
Height, door open	96.8 cm (38.1 in.)
Weight	51.7kg (114.0 lb)
Ventilation clearances (sides and rear)	7.6 cm (3.0 in.)
Electrical requirements	120 VAC, 15 A, 60 Hz 230 VAC, 10 A, 50 Hz 200 VAC, 12.5 A, 50/60 Hz
Maximum heat dissipation into room under steady-state conditions	3073 Btu/hr (0.9 kW)

Noise level 0.91 m (3 ft) in front of centrifuge <65 dBa

1.1.2 Allegra 6R / Spinchron R Specifications

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

Speed

Set (in 200-rpm increments)	0 to 8000 rpm
Display	±30 rpm of actual

Set time

Timed run	up to 30 min
Continuous run	HOLD ( )

Temperature

Temperature setting (refrigerated models only)	–10 to 40°C
Normal operating range (refrigerated models only)	–5 to 25°C
Temperature display (refrigerated models only)	actual chamber temp ±2°C
Ambient temperature range	10 to 35°C
Ambient temperature range for optimum operation	10 to 25°C

Humidity restrictions <95% (noncondensing)

Dimensions

Width	76 cm (30 in.)
Depth (overall)	66 cm (26 in.)
Depth (at base)	58.4 cm (23.0 in.)
Height, door closed	39.4 cm (15.5 in.)
Height, door open	94 cm (37 in.)
Weight	75.8 kg (167 lb)

Ventilation clearances (sides and rear) 7.6 cm (3.0 in.)

Electrical requirements 120 VAC, 15 A, 60 Hz
230 VAC, 10 A, 50 Hz
100 VAC, 12.5, 50/60 Hz

Maximum heat dissipation into room under steady-state conditions 5425 Btu/hr (1.9 kW)

Noise level 0.91 m (3 ft) in front of centrifuge <65 dBa

1.1.3 Allegra 6KR / Specifications

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

Speed	
Set (in 200-rpm increments)	0 to 8000 rpm
Display	± 30 rpm of actual
Set time	
Timed run	up to 30 min
Continuous run	HOLD ( )
Temperature	
Temperature setting (refrigerated models only)	–10 to 40°C
Normal operating range (refrigerated models only)	–5 to 25°C
Temperature display (refrigerated models only)	actual chamber temp ±2°C
Ambient temperature range	10 to 35°C
Ambient temperature range for optimum operation	10 to 25°C
Humidity restrictions	<95% (noncondensing)
Dimensions	
Width	54.6 cm (21.5 in.)
Depth (overall)	66.0 cm (26.0 in.)
Depth (at base)	58.4 cm (23.0 in.)
Height, door closed	67.3 cm (26.5 in.)
Height, door open	125.7 cm (49.5 in.)
Weight	90.3 cm (199.0 in.)
Ventilation clearances (sides and rear)	7.6 cm (3.0 in.)
Electrical requirements	120 VAC, 15 A, 60 Hz 230 VAC, 10 A, 50 Hz 200 VAC, 12.5 A, 50/60 Hz
Maximum heat dissipation into room under steady-state conditions	5425 Btu/hr (1.9 kW)
Noise level 0.91 m (3 ft) in front of centrifuge	<65 dBa

1.1.4 Allegra 6 General Description

The Beckman Allegra 6 centrifuge generates centrifugal forces required for a wide variety of applications. Together with the Beckman rotors designed for use in this centrifuge.

Available Rotors

Refer to the appropriate rotor manuals for complete rotor descriptions.

Rotor Profile and Description	Max RPM	Max RCF (× *g*)	Max Capacity	Rotor Manual Number
GH-3.8A Horizontal (4 place) Buckets (*r*max = 204 mm) Carriers (*r*max = 163 mm)	3750 3250	3210 1924	4 × 750 mL 4 × 192 mL	GS6-TB-017
GH-3.8 Horizontal (4 place) Buckets (*r*max = 204 mm) Carriers (*r*max = 163 mm)	3750 3250	3210 1924	4 x 750 ml 4 x 192 ml	GS6-TB-003
PTS-2000 Horizontal (4 place) Sector base, 100-mm tube (*r*max = 170 mm) Sector base, 75-mm tube (*r*max = 160 mm) Tube base, 16-mm tube (*r*max = 176 mm) Tube base, 13-mm tube (*r*max = 176 mm) Micro Plus carriers (*r*max = 163 mm)	3250 3250 3250 3250 3250	2010 1890 2080 2080 1920	7 × 10 mL (each carrier) 7 × 7 mL (each carrier) 20 × 10 mL (each carrier) 20 × 7 mL (each carrier) 4 × 192 mL	SP-TB-008
GH-4.7 Horizontal (4 place) *(r max = 182 mm)*	5730	4560	4 x 250 ml	GS-TB-024
GA-6 Fixed Angle, 35° (6 place) *r*max = 137 mm	6100	5710	6 × 250 mL	GS-TB-023

Housing

The centrifuge housing is made of sheet steel over a steel chassis and is finished with urethane paint. The control panel overlay is made of coated polycarbonate. Polyvinyl chloride lines the interior walls of the centrifuge housing for sound and temperature insulation.

Door

The structural steel door has a strobe port for speed verification. In nonrefrigerated models, the door has two filtered air-intake ports for rotor cooling. An electromechanical door lock system, together with a manual lock, prevents run initiation unless the door is closed and latched. When a run is in progress, the door locks automatically and can not be opened unless the power is on, the rotor is virtually stopped (spinning less than 40 rpm), and the manual lock is in the UNLOCK position. If there is a power failure, the door lock can be manually tripped for sample recovery.

Rotor Chamber

The aluminum rotor chamber is coated with a chemical-resistant epoxy finish. The drive shaft and neoprene rubber boot surrounding the drive shaft are visible in the chamber bottom. A neoprene gasket around the chamber top assures sealing. (Centrifuge gaskets have not been designed as bioseals for aerosol containment.) The thermistor is also visible in refrigerated models.

Nonrefrigerated models only—During centrifugation, the rotor movement draws air through the filtered air-intake ports in the door into the chamber bowl, where it circulates around the rotor. Holes in the side of the bowl allow air to flow out to the exhaust ports beneath the centrifuge. This air flow provides cooling for the rotor.

Drive

The direct-drive motor has permanently lubricated, sealed bearings. A tie-down screw secures the rotor to the drive shaft. The resilient suspension ensures that loads will not be disturbed by vibration, and prevents damage to the drive shaft if an imbalance occurs during centrifugation.

Refrigeration System (Refrigerated Models Only)

A refrigeration compressor circulates CFC-free refrigerant through copper tubing wrapped around the chamber bowl, which is insulated to increase refrigeration efficiency. A thermistor regulates the compressor to maintain chamber temperature to ±2°C of set temperature.

NOTE: To avoid chamber icing, refrigeration is off when the door is open. The centrifuge door must be closed *and latched* for the refrigeration system to begin operating.

Safety Features

Safety features include the following:

- The door has an electromechanical door-locking mechanism and a secondary (manual) lock to prevent operator contact with spinning rotors. When the door is closed it locks automatically. It can be unlocked only by pressing the DOOR switch to OPEN, and opened only when the power is on, the rotor is at rest, and the manual lock is in the UNLOCK position. Two independent monitoring systems prevent the door from opening if the rotor is spinning.
- A steel barrier ring surrounds the aluminum rotor chamber to provide full operator protection.
- An imbalance detector monitors the rotor during the run, causing automatic shutdown if rotor loads are severely out of balance. At low speeds, an incorrectly loaded rotor can cause imbalance. Rotor instability can also occur if the centrifuge is moved while running, or if it is not resting on a level surface.
- An anchoring system is provided to secure the centrifuge in place. The anchoring system (bolts that anchor a benchtop centrifuge to the laboratory bench; a stationary tray to roll a kneewell centrifuge into for operation) is designed to minimize the possibility of injury or damage that could result from centrifuge movement in the event of a major rotor mishap.

CFC-Free Centrifugation

To ensure minimal environmental impact, no CFCs are used in the manufacture or operation of Allegra 6 series and Spinchron series centrifuges.

SECTION 2

INSTALLATION

2.1 Safety Notice

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

Safety During Installation and/or Maintenance

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

Electrical Safety

To reduce the risk of electrical shock, this equipment uses a three-wire electrical cord and plug to connect the centrifuge to earth-ground. To preserve this safety feature:

- Make sure that the matching wall outlet receptacle is properly wired and earth-grounded. Check that the line voltage agrees with the voltage listed on the name-rating plate affixed to the centrifuge.
- Never use a three-to-two wire plug adapter.
- Never use a two-wire extension cord or a two-wire non-grounding type of multiple-outlet receptacle strip.

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

Safety Against Risk of Fire

Certain electrical circuits within this equipment are protected by fuses against overcurrent conditions. For continued protection against the risk of fire, replace only with the same type and rating specified.

This centrifuge is not designed for use with materials capable of developing flammable or explosive vapors. Do not centrifuge such materials (such as chloroform or ethyl alcohol) in this centrifuge nor

handle or store them within the required 30-cm (1-ft) clearance "envelope" surrounding the centrifuge.

2.2 Installation Requirements

WARNING:

This centrifuge weighs 51.7 kg/114.0 lb (nonrefrigerated benchtop), 75.8 kg/167 lb (refrigerated benchtop), or 90.3 kg/199.0 lb (refrigerated kneewell). DO NOT attempt to lift or move it without assistance from This centrifuge weighs 51.7 kg/114.0 lb another person.

WARNING:

Do not place the centrifuge near areas containing flammabl fluids. Vapors from these materials could enter the centrifuge's air system and be ignited. Never bring any flammable substances within the 30-cm (1-ft) area surrounding the a clearance envelope of 7.6 cm (3 in.) around an operating centrifuge. No persons should be within this clearance envelope while the centrifuge is operating.

Space and Location Requirements

Carefully remove the centrifuge and accessories from the shipping container. Save the container and packing materials for possible future relocation or storage of the centrifuge.

- Select a location away from heat-producing laboratory equipment, with sufficient ventilation to allow for heat dissipation.
- Position the centrifuge on a level surface (a sturdy table or laboratory bench for benchtop models) that can support the weight of the centrifuge (refer to SPECIFICATIONS in Section 1) and resist vibration.
- Allow a 7.6-cm (3-in.) clearance at each side and the back of the centrifuge to ensure sufficient air circulation. Dimensions are shown in Figure 2-1.
- Ambient temperature during operation should not exceed 35°C (95°F). Relative humidity should not exceed 95% (noncondensing).

Use the appropriate anti-rotation kit to secure the centrifuge to the working surface. The anti-rotation kit is designed to minimize the possibility of injury or damage that could result from centrifuge movement in the event of a rotor mishap.

- The anchoring kit for a benchtop centrifuge contains bolts to secure the centrifuge to the table or bench. Complete instructions (SP-TB-007) for installing the anti-rotation kit are included with the kit, which is shipped with the centrifuge.

- The anchoring kit for a kneewell centrifuge contains a stationary tray to roll the centrifuge into for operation. Complete instructions (GS6-TB-007) for installing the anti-rotation kit are included with the kit, which is shipped with the centrifuge.

Electrical Requirements

Allegra 6	Allegra 6R / Spinchron R	Allegra 6KR
120 VAC, 8 A, 60 Hz	120 VAC, 12 A, 60 Hz	120 VAC, 12 A, 60 Hz
230 VAC, 4 A, 50 Hz	230 VAC, 8 A, 50 Hz	230 VAC, 8 A, 50 Hz
100 VAC, 10 A, 50/60 Hz	200 VAC, 10 A, 50/60 Hz	200 VAC, 10 A, 50/60 Hz

A 1.8-m (6-ft) power cord with grounded plug is supplied with the centrifuge. In regions where a different plug is required to meet local electrical and safety requirements, contact your local Beckman representative.

Make sure the voltage imprinted on the name rating plate affixed to the back of the centrifuge agrees with the line voltage of the outlet used. With the POWER switch in the OFF (O) position, plug in both ends of the centrifuge power cord. If there is any question about voltage, have a qualified service person measure it under load while the drive is operating.

To reduce the risk of electrical shock, this equipment uses a three-wire electrical cord and plug to connect the centrifuge to earth-ground. To preserve this safety feature:

- Make sure that the matching wall outlet receptacle is properly wired and earth-grounded.

- Never use a three-to-two wire plug adapter.

- Never use a two-wire extension cord or a two-wire non-grounding type of multiple-outlet receptacle strip.

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

NOTE:

During transport between areas with varying temperatures, condensation may occur inside the centrifuge. Allow sufficient drying time before running the centrifuge.

2.3 Customer Training and Instrument Demo

The following check list is useful when customer training is required.

Adjust your training to the customer's needs.

Refer to User's Manual for all of the following:

Explain:

Rotors
Warranty
Maintenance
Responsibility
Cautions

Descriptions of instrument
Functions
Controls
Indicators
Rotor chamber
Temperatures sensing and control
Drive
Safety features
Name rating plate, serial number

Run the instrument

1. Turn on power to the instrument. Open the chamber door.
2. Enter speed of 3,000 RPM
3. Enter Temp 20C
4. Enter Time 30 min.
5. Perform a test run to verify parameter input.
6. Verify the temperature and speed control are functioning.
7. If the test run is satisfactory then proceed to instruct the customer on proper operation of the instrument.

Explain:

Troubleshooting
Customer maintenance items
Beckman Coulter Field Service, service agreements, etc.
Accessories and options that are available for the instrument
How to get applications support from Beckman Coulter

SECTION 3

SERVICE PROCEDURES

3.1 Mechanical Systems

3.1.1 Mechanical Safety Reminders

***WARNING*:**
- Maintenance should be performed only by trained, qualified personnel.
- Turn the power off and disconnect the instrument from main power prior to performing service.
- Refrigerant gas may cause drowsiness and will displace oxygen in an enclosed area. Avoid inhalation of this gas.
- Do not place hands or fingers in the instrument while instrument is in operation.
- Use only Beckman or Beckman approved replacement parts.

3.1.2 Required Tools

Standard hand tools, standard refrigeration tools.

3.1.3 Control Panel Replacement

A. Open lid, TURN POWER SWITCH OFF AND DISCONNECT POWER CORD.

B. Remove the front panel perimeter hardware (do not remove latch mounting screws).
Benchtop (non-refrigerated) **10** Allen screws and **4** hex screws (bottom side).
Benchtop (refrigerated) **10** Allen screws and **5** hex screws (bottom side).
Kneewell: **10** Allen screws and **4** hex screws (bottom side).

C. Remove control panel foam (non-refrigerated).

D. Disconnect all harness connections.

E. Reverse the above steps to replace the control panel.

3.1.4 Chamber Bowl Replacement (Non-Refrigerated)

A. Open lid, TURN POWER SWITCH OFF AND DISCONNECT POWER CORD.

NOTE: Prior to removing bowl, remove the black Allen head screw, located inside the bowl on the left front side.

B. Remove bowl including drive bellows (boot) and door gasket by pulling up. The rotor torquing bar may be used to pull the bowl upward by inserting the bar into one of the air flow holes.

NOTE: During re-assembly insure the black Allen head screw in the bowl is aligned with the arrow on top of housing.

C. Reverse the above steps to replace the chamber bowl.

3.1.5 Drive Motor Replacement (Non-Refrigerated)

A. Remove chamber bowl per step 3.1.4.

B. Removed large piece of foam from behind the front panel and disconnect motor harness connectors J/P 1,9 and 12.

C. Remove the six symmetrically spaced motor mounting lock-nuts, washers and grommets.

D. Pull drive upward, including the blue support ring, while feeding harness through motor insulating foam.

E. To reinstall drive, place drive on triangular plate, feed harness through the drive opening then through the slit in the motor insulating foam and up over the ballast ring. Carefully set drive down over the screws and ensure harness is not pinched. Lightly coat the six new grommets with vacuum grease. Place grommets over drive mounting screws followed by flat washers. Tighten the six lock-nuts until they are flush with top of screws. Reconnect harness connectors J/P 1,9 and 12.

NOTE: The boot must remain completely seated down around the motor cover to prevent contact with the rotor.

F. Replace foam pad behind control panel.

G. Reinstall chamber bowl per 3.1.4.

3.1.6 Drive Motor Replacement (Refrigerated)

A. Remove the control panel, per step 3.1.3.

B. Remove drive bellows (boot) by pulling it upward and out of chamber.
C. Remove the six symmetrically spaced motor mounting lock-nuts, washers and grommets.

D. Pull drive upward, including the blue support ring, while feeding harness through motor insulating foam.

E. To reinstall drive, place drive in chamber on a towel or pad to prevent scratching bowl. Feed harness through the motor opening then through the slit in the motor insulating foam and up over the ballast ring. Carefully set drive down over the

screws and ensure harness is not pinched. Lightly coat the six new grommets with vacuum grease. Place grommets over motor mounting screws followed by flat washers. Tighten the six lock-nuts until they are flush with top of screws. Reconnect harness connectors J/P 1,9 and 12.

NOTE: The boot must remain completely seated down around the motor cover to prevent contact with the rotor.

G. Replace drive bellows (boot).

F. Replace front panel.

3.1.7 Drive Motor Brush Inspection Removal

A. Follow the appropriate procedure to remove the drive motor per step 3.1.5 or 3.1.6.

B. When removing the brushes for inspection, mark each one so they can be reinstalled in the same orientation if they are not being replaced.

C. The brushes used in the Allegra 6 motor are called Auto-Stop. A wooden dowel will pop out when the brush wares down to ½ the length of the brush. Replace brushes if either one is less than 1/2 inch, (13mm) in length.

NOTE: To extend the life of replacement brushes, the new set must be seated prior to operating the drive at maximum RPM. Ensure commutator is in good condition.

D. Reinstall drive motor.

E. Seat new brushes by operating the centrifuge (with rotor only), at 2000 RPM for 4 hours.

3.1.8 Housing Removal

A. Remove control panel per step 3.1.3.

B. Non-refrigerated - remove bowl per step 3.1.4.

C. Remove the hex screws that fasten housing to chassis. This would include the (5/16”) screws located around the outside edge of the rear chassis and underneath the chassis on both sides.

NOTE: Do not remove door hinges.

D. Remove housing from chassis.

3.1.9 Hinge Replacement

CAUTION: Do not remove hinges with door in the closed position.

A. Open door completely.

B. While supporting the door, remove the (8) hex screws which hold hinges to rear chassis.

C. Remove and replace hinges while door is off unit.

D. Re-install door by reversing the above steps.

E. Adjust striker (door locking eye bolt) to maintain a good seal between the door and the bowl gasket (visual observation).

F. Tighten the locking nut to prevent rotation of the striker.

NOTE: Door hinges are non-adjustable.

3.2 Temperature Control Systems (Refrigerated Model)

3.2.1 Refrigeration System Safety

***Warning*:**	Refer to the safety notices in the front of this manual for cautionary notes when working with refrigeration system. Also, heed all brazing safety notes. Always recover the refrigerant.

3.2.2 Refrigeration Functional Test

A. The GH-3.8A swinging bucket rotor is recommended for this test. Replace loaded buckets with empty ones. Temperature measurements are performed by using 40ml of glycerol in two of the opposing buckets.

B. To pre-cool rotor and chamber, set temperature knob to -2° C, speed knob to 2000 RPM and timer for 30 minutes.

C. After pre-cool, set temperature knob to -10°C and increase speed to 3750 RPM. Set timer for 15 minutes.

D. At the instant the timer shuts off, record the indicated temperature. The reading should be -1° C or colder for 60 Hz units and + 1° C or colder for 50 Hz units.

E. When rotor stops use a temperature meter to measure the actual temperature of the sample (glycerol) and then record reading.

F. The difference between D and E should be within +/-2° C.

If functional test fails, proceed to 3.2.3

3.2.3 Checking the Refrigerant Charge

A. For Allegra 6R & Spinchron R, remove housing (R-H) that covers compressor. To access the refrigeration system in a Allegra 6KR, remove front panel assembly.

B. Connect charging manifold (“Access” control valves, P/N 964411, simplify connection to Schroeder service valves) and refrigerant supply as shown in figure 3-2.

C. Before opening Schroeder valves, purge charging manifold and hoses of air with R404a refrigerant supply at the low-side and high-side service valves.

D. To pre-cool rotor and chamber, set temperature knob to -2°C, speed knob to 2000 RPM and timer for 15 minutes.

E. After pre-cool, set temperature knob to -10°C and increase speed to maximum RPM of rotor. Set timer to HOLD.

F. After indicated temperature stabilizes, compare the ambient temperature at the condenser and the low-side and high-side reading on charging manifold with the charging graphs for 50 or 60Hz units.

G. If system pressures are low, add refrigerant R404a as a gas at the low-side to required pressure. Proceed to step 3.2.3 to check for leaks.

H. After removing refrigeration manifold, and access valves, ensure service valve caps are tightly replaced. Insulate low-side service valve with "Presstite" insulation tape.

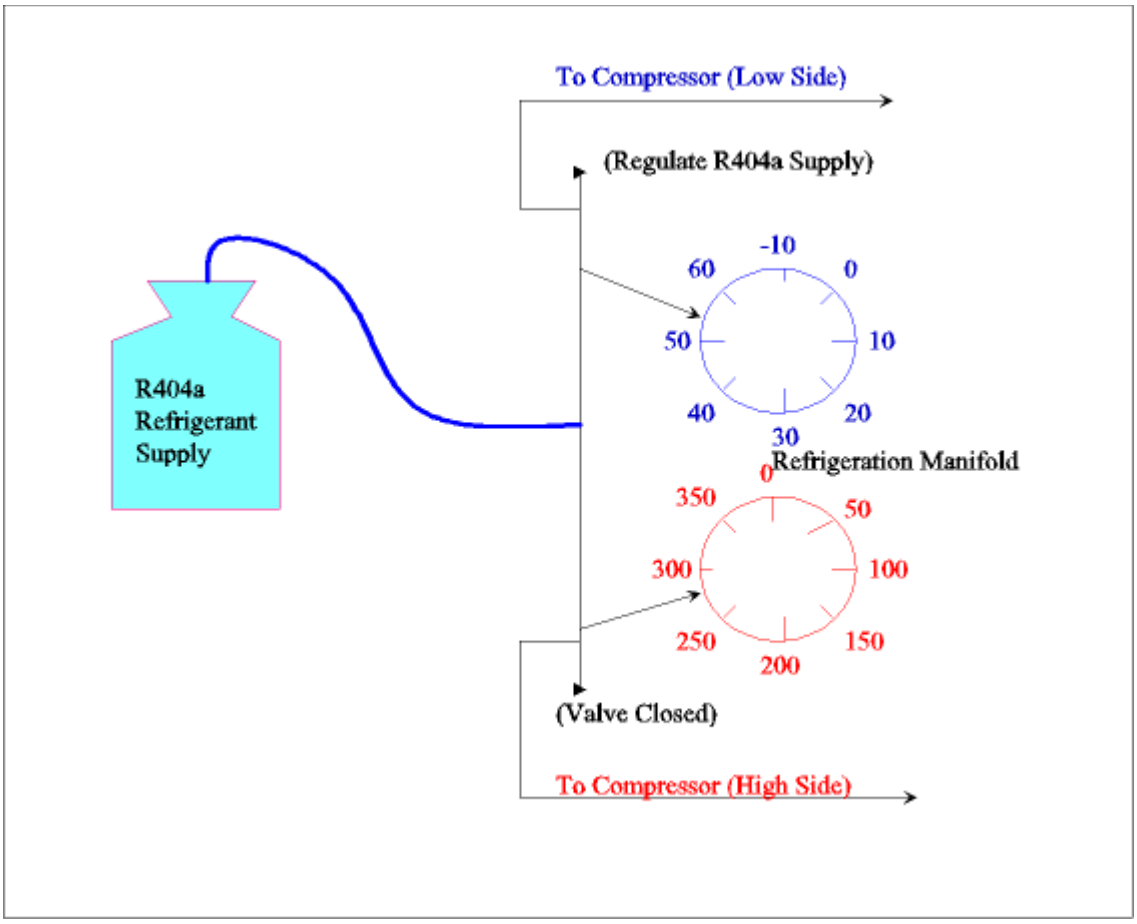
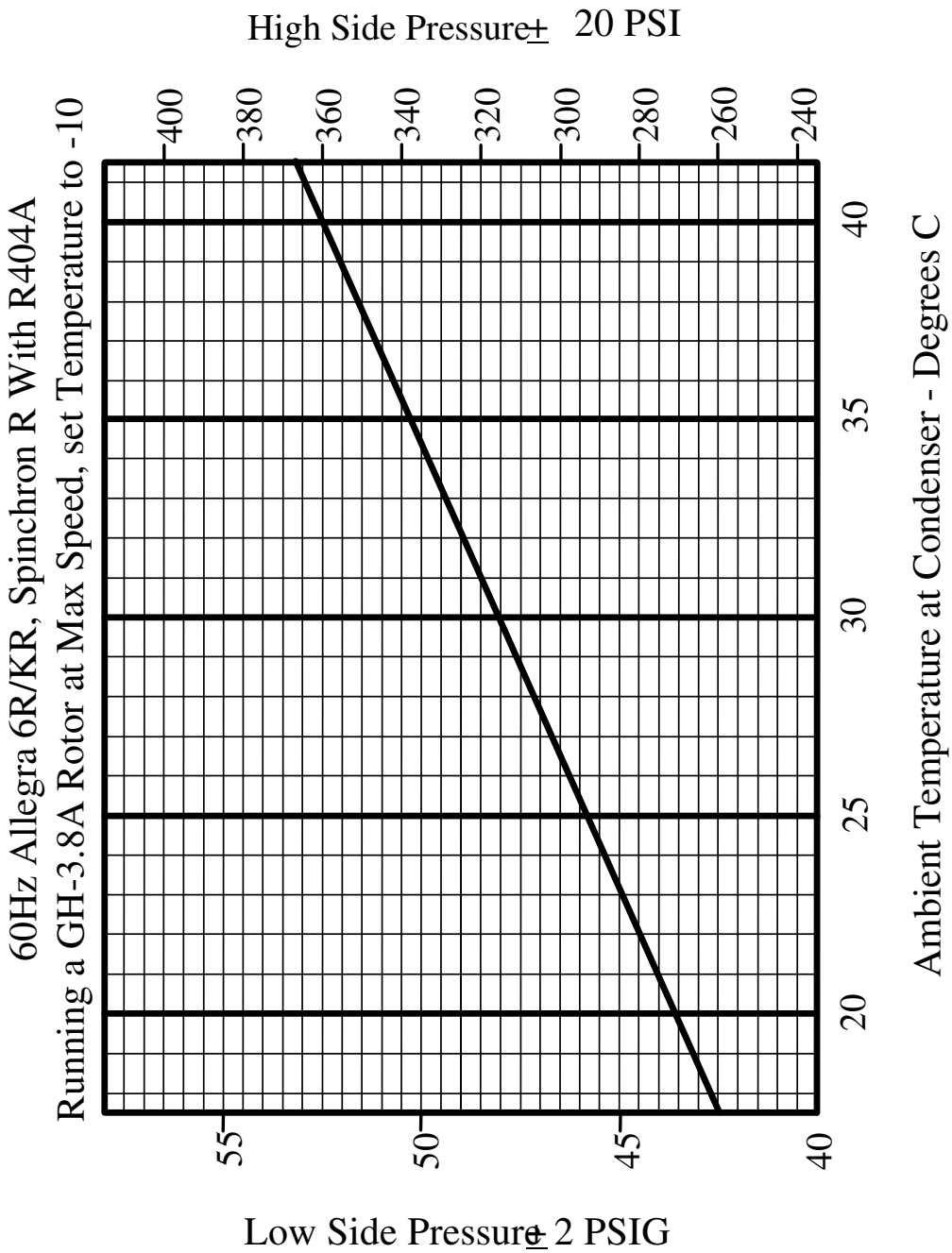
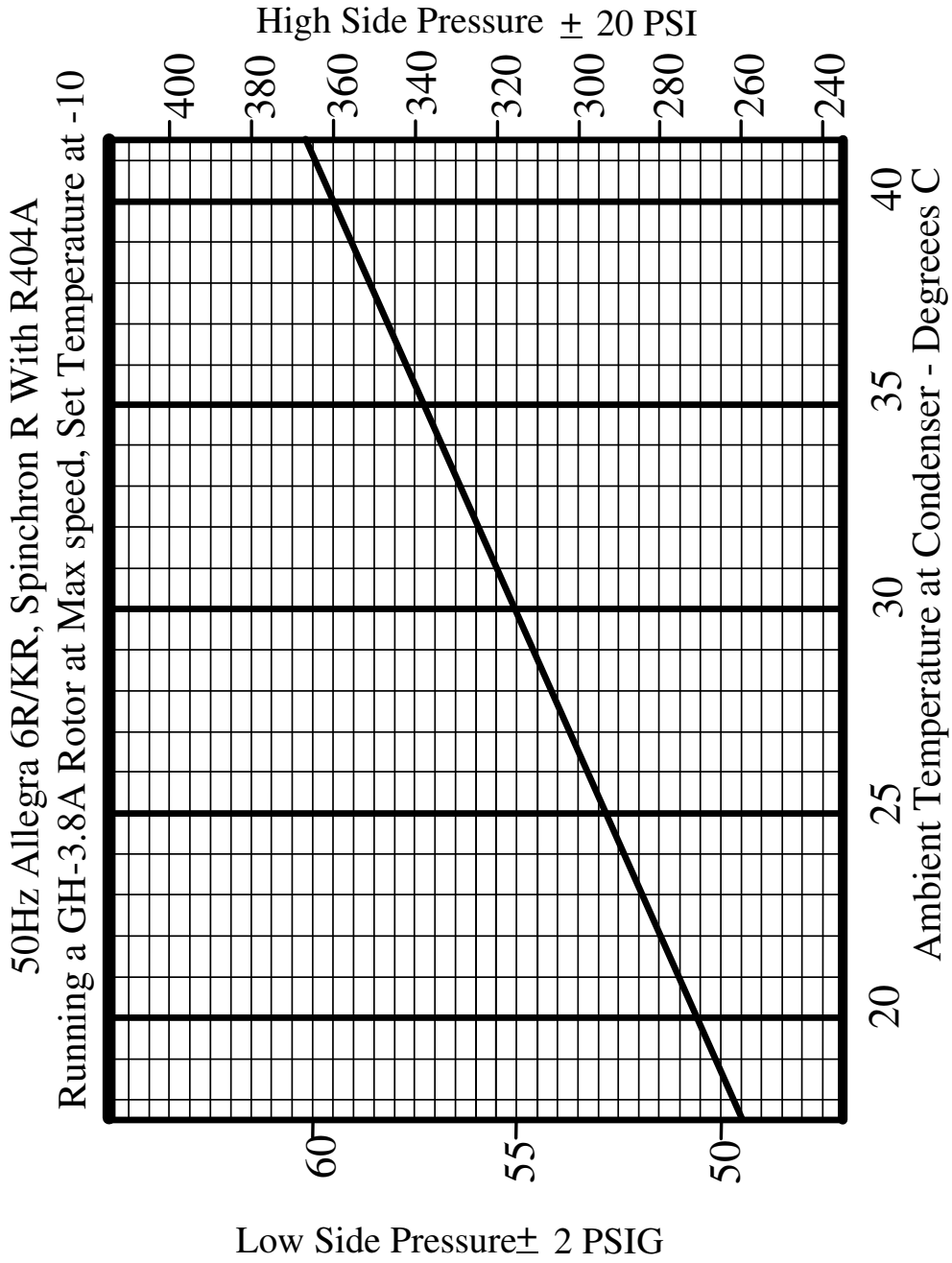

To Compressor (Low Side)
(Regulate R404a Supply)
-10
60
0
50
10
40
20
30
R404a
Refrigerant
Supply
Refrigeration Manifold
0
350
50
300
100
250
150
200
(Valve Closed)
To Compressor (High Side)

Figure 3-2


High Side Pressure ± 20 PSI
60Hz Allegra 6R/KR, Spinchron R With R404A
Running a GH-3.8A Rotor at Max Speed, set Temperature to -10
400
380
360
340
320
300
280
260
240
55
50
45
40
20
25
30
35
40
Ambient Temperature at Condenser - Degrees C
Low Side Pressure ± 2 PSIG


50Hz Allegra 6R/KR, Spinchron R With R404A
Running a GH-3.8A Rotor at Max speed, Set Temperature at -10
High Side Pressure ± 20 PSI
400
380
360
340
320
300
280
260
240
Ambient Temperature at Condenser - Degrees C
20
25
30
35
40
Low Side Pressure± 2 PSIG
60
55
50

3.2.4 Leak Test and Evacuation

A. Remove front panel and instrument housing as outlined in the mechanical systems section.

B. Connect the charging manifold per step 3.2.2.

C. Purge charging manifold and hoses of air before adding refrigerant to the system.

D. If system pressures are low, add refrigerant R404a as a gas to the low-side with compressor running.

E. Turn main power off. Allow pressures to equilibrate then test for leaks. (Requires a leak detector that will detect R404a).

F. Correct all leaks found in the system.

G. Evacuate the system to 50 microns by using an evacuation manifold and a high capacity vacuum pump, as shown in figure 3-3. After a vacuum is obtained turn compressor on for about 2-3 seconds to remove moisture trapped in compressor, turn compressor off and allow system to achieve 50 microns of vacuum.

H. Closed both access service valves at the compressor while the vacuum pump continues to run. Once the valves are closed, turn off the vacuum pump and remove the evacuation manifold.

I. Connect charging manifold and R404a refrigerant supply per procedure in step 3.2.3.

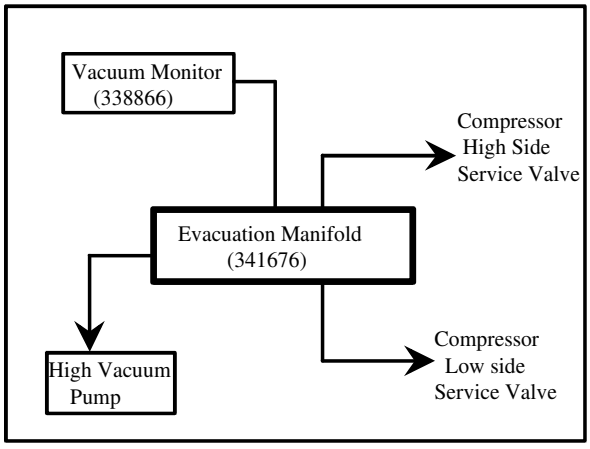


FIGURE 3 - 3

3.2.5 Chamber Bowl Replacement (Refrigerated)

A. Remove control panel, per step 3.1.3.

B. Remove drive motor, per step 3.1.6.

C. Remove housing, per step 3.1.8.

D. Remove refrigeration condenser fan (Benchtop).

E. Disconnect harnesses in brazing area and position them to avoid heat damage.

F. Recover refrigerant from system.

G. Remove Schroeder valves prior to brazing.

CAUTION: Do not damage or cut the capillary tube located inside the 1/4 inch tubing.

H. Benchtop - Observe brazing cautions. Unbraze refrigeration chamber line at low side service valve "T". Using a tube cutter, carefully cut the 1/4 inch diameter tubing approximately 2 inches (5 cm) from chamber foam wall.
Kneewell - Observe brazing cautions. Unbraze refrigeration chamber low-side line approximately 8 inches (20 cm) from chamber foam wall. Using a tube cutter, carefully cut the 1/4 inch diameter tubing approximately 8 inches from chamber.

I. Remove chamber support mounting hardware from bottom side of chassis.

J. Remove chamber.

K. Re-assemble the chamber, by performing the above steps in reverse order. Use a connecting coupler to braze the 1/4 inch tubing which contains the capillary. **DO NOT CUT OR DAMAGE THE CAPILLARY TUBE**. Evacuate, charge and leak test the refrigeration system per step 3.2.3.

3.2.6 Temperature Calibration

A. Power off, adjust temperature indicator needle to read 15°C by using meter zero adjustment located below meter face.

B. Remove front panel but do not disconnect harness.

C. Remove jumper (U1 TEMP), located on control bd. to the CAL position.

D. Disconnect thermistor by unplugging J/P21 (orange wires).

E. Power on, adjust R146 on control board for a reading of + 3.5°C on temperature meter. Be patient there is a short response time delay.

F. Ensure door latch mechanism is closed.

G. To check temperature knob calibration turn knob above and below 3.5°C. Compressor should turn on and off at 3.5°C +/- 1°C.

H. Turn power off and move JU1 jumper to the NORM position. Reconnect J/P21.

I. Replace front panel.

NOTE: Ensure chamber gasket and door form a good seal prior to performing refrigeration tests.

Resistance versus Temperature

10 K at 25 C

Temp. C	Res.	Temp. C	Res.	Temp. C	Res.	Temp. C	Res.
-50	441.3K	0	29.49K	20	12.26K	40	5592
-40	239.8K	1	28.15K	21	11.77K	41	5389
-30	135.2K	2	26.89K	22	11.29K	42	5193
-20	78.91K	3	25.69K	23	10.84K	43	5006
-10	47.54K	4	24.55K	24	10.41K	44	4827
-1	30.89K	5	23.46K	25	10.00K	45	4655
		6	22.43K	26	9605	46	4480
		7	21.45K	27	9227	47	4331
		8	20.52K	28	8867	48	4179
		9	19.63K	29	8523	49	4033
		10	18.79K	30	8194	50	3893
		11	17.89K	31	7880	51	3758
		12	17.22K	32	7579	52	3629
60	2760	13	16.49K	33	7291	53	3504
70	1990	14	15.79K	34	7016	54	3385
80	1458	15	15.13K	35	6752	55	3270
90	1084	16	14.50K	36	6500	56	3160
100	816.8	17	13.90K	37	6258	57	3054
110	623.5	18	13.33K	38	6026	58	2952
120	481.8	19	12.79K	39	5805	59	2854

3.3 Speed Adjustment

3.3.1 Speed Verification

If you wish to compare the actual rotor speed with the speed readout, proceed as follows, using a digital strobe.

NOTE: Calibration parameter values are at line voltage of 120 VAC for 60Hz units or 220 VAC for 50Hz.

A. Install rotor and tie-down nut. Blacken one half of the top side of the tie-down nut with a black ink marker.

B. Close door and set desired speed. Speed can be precisely set using ACCU-SET button.

C. Set timer knob to HOLD position (CCW).

D. When the rotor reaches set speed, strobe the rotor through the strobe port in the instrument door to verify the actual rotor speed with the display.

E. Display versus actual speed should be +/- 30 at 3750 RPM at nominal line voltage.

F. If there is a discrepancy adjust R16 on the display board. To increase value turn pot clockwise, decrease value by turning counter-clockwise.

NOTE: Maximum speed must be reduced to 3250 RPM when using Micro Plus Multiwell Carriers.

3.3.2 Speed Knob Adjustment

If set and indicated speed are not in agreement, the speed knob may need adjustment. Process as follows:

1. Install rotor. Set the speed know to 3000 RPM and the timer to HOLD. When the rotor speed stabilizes, adjust the speed knob until the display speed is 3000 RPM.

2. Loosen the set screws on the speed knob. Adjust the knob until it indicates 3000 RPM. Tighten the set screws.

3.3.3 Drive Current Adjustment

Warning:	To adjust drive current the screws around the front control panel have to be removed and the panel leaned forward. This will prevent the latch from keeping the door locked during drive operation. To operate the centrifuge safely, a door tie-down strap must be used. The part number for the door tie-down strap is 964455.

A. Turn power off.

B. Remove screws from front control panel and lean forward.

C. To operate the centrifuge safely during drive current calibration, use a tie-down strap to hold door closed.

D. Engage the door latch mechanism by manually closing the jaws on the latch.

E. Connect DVM to TP1 (blk) and TP2 (yel). set DVM to DC volt scale (low range).

F. Turn power on.

G. Set speed to 2500 RPM.

H. Turn time on.

I. Verify during acceleration that the voltage representing drive current is .8VDC $\pm$ .05VDC. Adjust drive current pot R156 as the drive accelerates between 1000 - 2000 rpm. Voltage will decrease as drive reaches speed.

3.3.4 Imbalance Procedure

With a GH 3.8 Rotor, the imbalance switch should trip with an 80g imbalance, with 20 g it should pass.

3.4 Troubleshooting

3.4.1 Resistance's*

120V Compressor	
Common to Run	1.3 ohm
Common to Start	6.4 ohm
120V Condenser Fan	54 ohm
220V Compressor	
Common to Run	5.9 ohm
Common to Start	26.5 ohm
220V Condenser Fan	235 ohm
Mag. Pickup (Red to Green)	675 ohm
Motor, 60Hz,	
Armature	1.7 ohm
Field	2.2 ohm

*Resistance values are Nominal DC given in ohms.

3.4.2 Diagnostic Messages

If the run is shut down prematurely due to one of four conditions, the diagnostic message, "8880" will be displayed in the RPM display. Refer to Table 1 to determine the nature of the error or problem, possible causes, and recommended actions to take.

Table 1. Shutdown/No-Start Diagnostics Chart

Possible Cause	Result	Recommended Action
Imbalance detector tripped.	Display will indicate "8880". Rotor will coast to stop, latch will not open.	- Turn timer OFF then turn power switch OFF. - Turning power switch back ON will clear diagnostic error. - Open chamber door. - Be sure rotor is properly installed on the drive shaft. - Check to be sure the rotor buckets and adapters are symmetrically loaded around the pivotal axis of the bucket, with containers of equal weight and density of each other. - Be sure the rubber boot is undamaged and is seated correctly around the motor cover. - Confirm instrument (Benchtop model) was installed on a sturdy laboratory table or counter.
Thermal cutout switch activated in drive motor.	"	- Turn timer OFF then turn power switch OFF. - Turning power switch back ON will allow door to be opened. Diagnostics will re-occur as long as motor is hot. - (Non-refrigerated) Check air inlet filters in door for obstruction. Remove filters and clean. - Be sure rotor is properly installed on drive shaft and boot is positioned down around motor cover.
Chamber overtemp.	"	- Refrigerated model only. - Turn timer OFF then turn power switch OFF. - Turning power switch back ON will clear diagnostic error. - Check temperature calibration. - Check chamber thermistor (10K @ 24°C). - Check solid state relay. - Check refrigerant charge.

Tacho meter signal loss	"	- Turn timer OFF then turn power switch OFF. - Turning power switch back ON will clear diagnostic error. - Check Tach signal at TP9. Signal should be +12VDC square wave. If you do to have signal, check Tach pick-up assembly located on bottom of drive assembly. - Check Tach voltage at TP10. - Check ACCU-SET, read set speed voltage at TP10. - Check display board.

3.4.3 Other Possible Problems

Possible malfunctions not indicated by diagnostic messages are described in Table 2, along with probable causes and corrective actions required.

Table 2. Troubleshooting Chart

Problem	Probable Cause	Corrective Action
Rotor cannot achieve set speed.	*Line voltage below rating.	Check line voltage while instrument is under load.
	Commutator worn.	Replace brush set if worn less than 1/2 inch in length.
	Motor failure	Replace drive motor assembly.
Door will not open.	Power not on.	Replace drive motor assembly.
	Rotor spinning over 40 RPM.	Apply power to instrument.
	Latch stuck.	Rotor must be spinning less than 40 RPM before door can be opened. See Emergency Access, 3.4.4.
Rotor speed shows "0000" and rotor is spinning.	Tach voltage loss.	Check Tach Presence at DS3. Check Tach pulse at TP9, should be +12V. Check Tach voltage at TP10, check (ACCUSET) set speed voltage at TP10, check display board.
Rotor speed display is blank.	Lost power to display.	Check plug J14.
	Fuse blow.	Check F2 and power supply voltages.
Rotor does not achieve set speed.	Line voltage below rating.	Check Tach voltage while instrument is under load.
	Speed calibration is off.	Check speed verification, and speed knob adjustment. Per sec 3.3

* Line voltage must be 120 VAC 60Hz or 220 VAC 50Hz to maintain top speed with maximum load.

3.4.4 Emergency Access

If the facility power fails only momentarily, the centrifuge will resume operation when power is restored and the rotor will return to set speed. However, if the rotor comes to a complete stop you will have to restart the run when the power is restored. In the event of an extended power failure, it may be necessary to trip the door-locking mechanism manually to remove the rotor and retrieve your sample.

> ***Warning*: Under NO circumstances should you attempt to override the door interlock system while the rotor is spinning. The following procedure may expose the operator to the possibility of contact with a spinning rotor. Turn the power off and disconnect the centrifuge from the main power source before proceeding.**

1. Press the POWER switch to OFF and unplug the power cord from the power source.
2. Make sure that the rotor is not spinning.
3. Move the secondary latch lever to UNLOCK.
4. Insert a 4-mm (^{5}/32-inch) internal hex wrench into the access opening located on the left side of the front panel.
5. Turn the hex wrench to the right (clockwise) until you hear a “click” or the door opens.
6. Open the door and remove the sample.

3.5 Preventative Maintenance

1. Purpose: To maintain the instrument in good operating condition; to insure the installation of mandatory modifications; and to minimize user instrument down time.

2. Preliminary: Schedule and obtain permission from operator/owner to perform the preventative maintenance call. Ask if there are any instrument problems. Ask if instrument is safe to work on. This means no pathogenic or radioactive contamination. If instrument is not safe to work on then request customer to clean and/or sterilize the instrument and rotors.

3. The call:

   A. Perform test run and check instrument operation. This includes display digits, temperature control (R units), refrigeration system (R unit), motor operation.
   B. DISCONNECT INSTRUMENT POWER by unplugging instrument power cord.
   C. Remove chamber bowl and motor bellows (non-refrigerated) per step 3.1.4, front panel per step 3.1.3.
   D. Clean instrument. Clean or replace air filters.
   E. Inspect and correct all instrument problems such as loose hardware, chaffing burnt wires, pitted relay contacts, cracked hinges, cross-threaded rotor
   F. Inspect rotors to insure they are maintained correctly per rotor instruction manual.
   G. Check instrument door operation to insure it functions correctly.
   H. Perform all necessary instrument calibrations.
   I. Reassemble instrument and make a final test run.

4. Call acceptance:

   A. Discuss any problems with the customer.
   B. Explain service performed to the customer. Make recommendations as to proper rotor and instrument maintenance.
   C. Review commitments and thank customer.

SECTION 4

SCHEMATICS

4.1 Circuit Description

This document is written to describe the electronics circuit for Allegra 6/Spinchron R products. The following 2 sections will fulfill this purpose.

The first section is a general description of the system.

The second section is a detail circuit description of the control board.

4.1.1 General Description

Power - When the power switch is turned on, the AC voltage goes through an auto transformer, if required, (per wiring diagram for the country that it is being assembled for) otherwise AC directly powers the input transformer which feeds the power supply circuit, where +24V, +12V, +5V, and -6.2 DC are generated.

The refrigeration unit receives power through a sold state relay controlled by the low voltage logic circuit. If the door is opened the refrigeration is turned off.

The door latch system has a solenoid and two switches built in. When the door is closed with the rotor stopped, the door relay, controlled by low voltage circuits, allows the front panel “DOOR” switch to energize the door solenoid. When the door latch is opened, the other internal door latch switch is opened, disconnecting the power to the high voltage circuit and the SCR bridge.

A power sense circuit detects lack of voltage on the high voltage side and asserts the reset line on the low voltage circuit side. Once the door is closed the power to the high voltage circuit is resumed and the reset line releases after one second, therefore the system could be operated.

Start - The timer controls the start, stop, and time of the run. When the timer is turned on or switched to the "HOLD" position, the door is locked, the tach confidence is charged up and the drive relay is energized. When the timer is turned off brake current is generated, and the rotor brakes or coasts to a stop. Below 40 RPM the door is unlocked, therefore the latch solenoid can be energized, opening the door latch.

Tach, Speed Control, Error Detection - A crystal controlled oscillator circuit outputs a fixed pulse width for the each tach pulse received. The fixed width tach pulses charge up a tach confidence capacitor which maintains tach confidence. If you lose tach pulses and

the timer is still on, a tach failure is generated after 20 seconds. This signal as well as the imbalance, drive overtemp, or chamber overtemp (refrigerated models) will trigger an error detection latch which disables the drive current command, and the drive will coast to a stop. The door latch cannot be opened until the diagnostic error (8880) is reset by a power off/on cycle. A frequency to voltage converter generates the tach voltage which is shown on the display. The actual tach voltage is compared to the set speed voltage. This signal controls the drive current command.

Temperature Circuit - The refrigeration circuit is controlled by the temperature set on the front panel. The chamber temperature is displayed on an analog meter. If chamber temperature is above the set temperature the compressor is turned on via a solid state relay. If the chamber temperature is below the set temperature the compressor is turned off. The temperature circuit is calibrated using a fixed resistor and a potentiometer on the control board.

Brake - There are three possible settings for the brake switch on the front panel:

- Off - Removes braking entirely and allows the rotor to coast to a stop from set speed.

- Low - Activates low dynamic braking down to 50 rpm, and is used for slower deceleration to avoid re-mixing or re-suspension of sample.

- High - Activates high dynamic braking that starts immediately after timer is turned off. When rotor speed reaches 50 rpm, all braking stops and the rotor coasts to a stop.

During braking, the SCR's are fired but the resulting current flows through the motor field winding only. The armature becomes a generator dissipating the power through brake resistors, therefore braking.

Reset - Reset is high under the following conditions:

- If there is a power failure for over 100 millisec.
- If the power to the high voltage circuit is interrupted.
- If the power switch is turned off/on.

Back EMF - If tach fails, there is a window in which the door relay could be energized allowing the door latch to be opened. To eliminate this condition we monitor the back EMF voltage from the armature.

4.1.2 Detailed Circuit Description

This circuit description is according to reference schematic DWG No. 358737-01.

Power Supply Circuit

The power supply transformer provides a 40 VAC on its secondary which is rectified by CR8, 9, 10, and 11. The +24VDC (TP4) is filtered by C3 and supplies power to all relays on the board. This voltage is used to generate the regulated +12V (TP6) and +5V (TP7) using U8 and U9. The negative side of the bridge generates the -6.2 VDC using R19 and VR1. It also generates a sync pulse that is taken to the high voltage circuit, through opto transistor U5, this sync pulse is used in the constant current circuit for the drive.

Reset

A momentary reset pulse is generated by U12 on power up, and anytime there is a power interruption over 100 ms. The reset pulse; disables the SCR opto-coupler U6, and the refrigeration s.s. relay. It discharges C24 and C37 to prevent false triggering of the tach confidence, drive overtemp, chamber overtemp, and imbalance diagnostics. Opening the chamber door generates a reset that is always high, turning off the refrigeration s.s. relay.

Start

To start the instrument the timer has to be on and the chamber door closed. This takes J14-9 to ground and U15F-6 low. U15F-11 is now high. U15G-10 goes low causing U10G-10 to go high, charging up C38 through R132. AR6A-1 goes high after three seconds causing U10A-16 go to low energizing the drive relay K3. When the timer was turned on, U15E-5 went high and pin 12 low. Whenever the timer is either turned ON or OFF, C40 will charge or discharge generating a 3 second pulse at the output of AR6B-7. This pulse will charge up C41 and C32 via R8, CR36, and CR35, putting a high on pin 13 of AR5D. AR5D-14 and AR4A-1 will go low (low = tach ok). Due to the discharge rate of C41 and C32, there is enough time for the drive to start turning and generate tach pulses to re-charge tach confidence capacitor C32. Therefore if there is no diagnostic error turning on Q2 through CR17, Q2 will be off after the three second pulse from AR6B-7.

Acceleration

When a run has been started, Q2 turns off and C25 starts charging up through R71, as the voltage gradually increases, AR6D-14 output which was low starts oscillating. Eventually its high level duty cycle increases to a solid high output which commands full current to the drive. A full current causes rotor acceleration. The slope with which C25 gets charged up determines the soft start of the drive current.

Since the set speed is higher than actual speed, the output of AR2D-14 is high. The high output doesn't effect the soft start operation due to CR15. At speed, AR2D-14 output regulates the voltage across C25 causing proper duty cycle on AR6D-14 to regulate the current to the drive maintaining the set speed.

Tachometer Circuit

Tach pulses are generated by a magnetic sensor. There are six pulses per each rotor revolution. The pulses can be viewed on DS3 or at TP9 using an oscilloscope. The tach pulses trigger a one shot, AR5B, which enables a counter, generating a 572 micro second pulse for each tach pulse received. Due to using a crystal controlled oscillator and digital counter (U16), the pulse width is very stable and insensitive to the noisy environment within the centrifuge. The fixed pulses charge up the tach confidence capacitor C32 through R85. With C32 charged AR5D-14 stay low, and the system continues to run. The same pulses charge up tach voltage capacitor C31 through R84. The voltage across C31 indicates the exact speed of the rotor. Normally the tach voltage is selected when U13A-10 is high, and displayed. Set speed voltage is selected when U13A-10 is low, using Accu-set. Tach voltage can be observed at TP10. AR2A and AR2B are used to buffer the actual speed and set speed voltages from multiplexer U13A.

Temperature Control (refrigerated only)

The temperature in the chamber is sensed by RT1, a 10K thermistor. The thermistor output is linearized by resistors R124 and R125. AR3D is used to drive the temperature meter, M1. The meter is a zero center type and is set up so that at 15°C the voltage is exactly 1/2 of the bridge supply voltage, hence no zero adjust is required. R146 is used to calibrate the temperature meter. Temperature setting is done by R1, a 10K variable resistor. R90, R91, and R92 adjust the span of the set voltage to match the thermistor output. When the output of AR3B-7 is low U15A-16 will go high turning the compressor off via the solid state relay. AR3C provides over-temperature sensing. R95 and R96 set a voltage level corresponding to about 50°C. If the temperature exceed 50°C, the output of AR3C-8 will go high causing AR4B-7 to go high after a time delay determined by R9 and C24. When AR4B-7 goes high it causes AR6C-8 to go high. At this point several conditions will follow:

1. This will turn on Q2 via R68, CR17, and R69. AR6D-14 will go low disabling opto-transistor U2, current command to drive.

2. AR2C-8 will go low preventing the door latch from opening.

3. U11D-13 will go low disabling the opto-SCR U6.

4. Q1 will turn on, allowing a high at J14-10. This will generate the diagnostic error "8880" on the display. The diagnostic can be cleared by turning the power switch off/on, after the temperature has dropped below 50°C.

High Voltage Circuit

The high voltage circuit is referenced to the line potential. An isolation box must be used when probing this circuit. The high voltage circuit and the opto-SCR (U6) are protected by F5 (1/4 amp) fuse. VR2 provides the +12 volt reference to AR1. This circuit controls the firing angle required by the SCR bridge. The sync pulses from the power supply circuit (U5) provide low going pulses at the output of comparator AR1B-7. The low going pulses discharge the voltage across C14 through CR4. During the high level of the pulses, C14 is charged up through R14; this generates a non-linear sawtooth on the input of the comparator AR1A-3 which is used as a reference to determine the firing angle of the SCR's. The non-linearity of the sawtooth is to compensate for the non-linearity of the AC current so the resulting current adjustments could be linear. U5 is designed in such a way that if it is open or missing from the circuit, AR1A-3 would stay low and the SCR's would not fire. CR4 is selected to be a IN4005 so that it could stand the high voltage potential across it in case of component failures. R14 and R153 are selected 1 watt due to
a high voltage drop cross them not due to high power dissipation. AR1D-14 controls the firing angle of the SCR bridge hence the current through the motor. Two loops control this amplifier; the voltage across the current sense resistor, R3, through R5 a 33.2K resistor, and the pulse train, generated by AR6D-14, sent to the high voltage circuit through opto-transistor U2. Pulses are converted to a voltage level by R25 and C6.

The currents at the summing node AR1D-13 generate a voltage level at AR1D-14 which gets compared to the non-linear sawtooth by comparator AR1A, resulting in a high going pulse at AR1A-1. This high going pulse turns on the opto-transistor U3 which forces a low going pulse at U11G-10 turning on DS1, the current command LED and U6, the opto-SCR. This pulse can be observed at TP-8 using an oscilloscope. The opto-SCR is controlled at different firing angles based on the pulse widths of the trigger pulse, thereby firing the gates of the SCR bridge for different duration’s. The voltage that is generated on the + side the of SCR bridge is filtered through a choke to reduce the RMS line current. When in brake mode the drive relay K3 is de-energized, allowing current to flow through the motor field winding only. The voltage generated by the armature is dissipated through the 100 watt brake resistor and at 1000 RPM a 25 watt brake resistor is paralleled by K4A relay contracts.

Back EMF and Door Circuit

If a tach failure happens, the drive starts accelerating for 6 seconds and then goes into a coast mode. The prevent the operator from activating the door latch, the circuit disables the door relay K5 by monitoring the back EMF generated by the armature. This voltage is sensed by AR1C-9, turning the opto-transistor U4 on. This will put a high U10D-4 causing a low at U10D-13 preventing the door solenoid from energizing. Back EMF is generated down to 250 RPM, at this time U4 is turned off causing a low at U10D-4. With U10D-13 open, R5D-14 (tach presents) will control the door latch relay K5. In normal operation, when the RPM is less than 40, tach confidence discharges and AR5D-14 goes high, activating the door latch relay K5. This allows the operator to open the door using the door switch.

Stop

To terminate a run the timer is turned off. U15F-6 will go high and U15F-11 low. U15G-10 will go high causing U10G-10 to go low discharging C38. Therefore releasing the drive relay K3 when AR6A-1 goes low after one second. Meanwhile the rising edge on U15E-12 triggers the one shot AR6B, generating a three second high going pulse which turns Q2 on . When Q2 is turned on capacitor C25 is discharged, the oscillator output of AR6D-14 goes low turning of opto-transistor U2 stopping the current to the motor windings due to K3 being de-energized. The generated armature voltage is dissipated through the 100W brake resistor. Max. brake relay K4 is energized below 1000 rpm. If the brake is off the rotor will coast to a stop.

Brake Circuit

Braking is performed by either low dynamic braking or high dynamic braking. During brake mode, K3 is de-energized and SCR voltage is applied to the field windings of the motor. This results in a generated EMF in the armature which causes current to flow through the 13 ohm resistor, giving low dynamic braking. At low speeds, < 1000 RPM, the EMF is lower, which requires an additional resistor in the circuit to maintain braking down to 50 RPM. When high brake is selected, K6 is energized for additional dynamic braking. If no brake is selected, the motor field is not energized.