Model 600/Model 400

Cryogenic Helium Compressor

Users Manual

Oxford Instruments Austin, Inc.
1340 Airport Commerce Dr.
Bldg. 1 Suite 175
Austin, TX 78741 USA
Sales: 800-611-8871
Support: 800-404-1055
cryo-sales@oxinst.com
support@austinscientific.com

www.oxford-instruments.com

OXFORD INSTRUMENTS

The Business of Science®

Oxford Instruments Austin, Inc. is a wholly-owned subsidiary of Oxford Instruments. For information about Oxford Instruments, visit the Oxford Instruments website at:

http://www.oxford-instruments.com

How to Contact Oxford Instruments Austin, Inc. Support:

For contact information and a complete listing of Direct Sales, Distributor, and Sales Representative contacts, visit the Oxford Instruments Austin, Inc. website at:

http:// http://www.oxford-instruments.com/businesses/industrial-products/austin

Oxford Instruments Austin, Inc. has made its best effort to ensure that the information contained in this document is accurate and reliable. However, the information is subject to change without notice and is provided "AS IS" without warranty of any kind, expressed or implied. Before placing orders, customers are advised to obtain the latest version of relevant information to verify that information being relied upon is current and complete. All products are sold subject to the terms and conditions of sale supplied at the time of order acknowledgment, including those pertaining to warranty, patent infringement, and limitation of liability. No responsibility is assumed by Oxford Instruments Austin, Inc. for the use of this information, including use of this information as the basis for manufacture or sale of any items, or for infringements of patents or other rights of third parties.

These documents are the property of Oxford Instruments Austin, Inc. and by furnishing this information, Oxford Instruments Austin, Inc. grants no license, expressed or implied, under any patents, copyrights, trademarks, trade secrets, or other intellectual property rights of Oxford Instruments Austin, Inc. Oxford Instruments Austin, Inc. , the copyright owner of the information contained herein, gives consent for copies to be made of the information only for use within the customer's organization as related to the use of Oxford Instruments Austin, Inc. products. The same consent is given for similar information contained on any Oxford Instruments Austin, Inc. website or disk used to distribute information to a customer. Oxford Instruments Austin, Inc. does give consent to the copying or reproduction by any means of the information contained herein for general distribution, advertising or promotional purposes, or for creating any work for resale. The names of products of Oxford Instruments Austin, Inc. or other vendors and suppliers appearing in this document may be trademarks or service marks of their respective owners that may be registered in some jurisdictions. A list of Oxford Instruments Austin, Inc. trademarks and service marks can be found at:

http:// http://www.oxford-instruments.com/businesses/industrial-products/austin

Contents

List of Figures

List of Tables

Revision History

Document Number 97-00046-000

Date	Revision	Description of Change
December	1.0.3	Change company address and name
March 2010	1.0.2	Make correction to low voltage tap setting description on Figure 4-1.
June 2009	1.0.1	Combine M600 and M400 manuals. Add new electrical box configuration information. Change document part number.

1 Preface

1.1 About Oxford Instruments Austin, Inc.

Oxford Instruments Austin, Inc., a wholly-owned subsidiary of Oxford Instruments, specializes in the manufacture and repair of cryogenic vacuum pumps, cryocoolers (refrigerators) and helium compressors for semiconductor, optical coating, linear accelerators, medical equipment, and R&D applications.

You can find just what you need from our range of products and support services:

- New Equipment - cryopumps, compressors, cryocoolers, and cryopump controllers such as the Model 600 / Model 400 Helium Compressor described in this manual.

- Comprehensive range of accessories for the installation of whole systems and a complete range of spare parts to repair cryopumps and compressors.

1.2 Other Services from Oxford Instruments Austin, Inc.

Oxford Instruments Austin, Inc. offers comprehensive refurbishment services for its own equipment as well as for that of most of our competitors. Our products and services are available through our global network of agents and dealers.

- Repair and refurbishment services - We offer our own quality products, as well as most other manufactures models, often with off-the-shelf availability.

- Exchanges - We offer our own quality products, as well as most makes of cryopumps and helium compressors, which are refurbished and fully warranted.

- Technical Support - Our support engineers will help determine if your cryopump system is operating correctly so that you can get your system back to optimum efficiency as soon as possible.

  To contact Oxford Instruments Austin, Inc. Technical Support:

  E-mail: support@oxinst.com
  Telephone: 1-512-441-9258 or Toll Free: 1-800-404-1055

- Installation - On-site installation services are available to guarantee performance and save you time.
- Training - We offer on-site training to help you and your staff to know more about your cryopump and compressor systems. Our training will give you confidence and the ability to maintain a highest possible uptime for your system.

1.3 About this Manual

The purpose of this manual is to provide our customers using the Model 600 / Model 400 Helium Compressor with the information needed to safely and efficiently operate the compressor when operating as part of a cryogenic refrigeration system. Such a system is often comprised of the following equipment:

- Model 600 / Model 400 helium compressor unit
- Coldhead(s) or cryopump(s)
- Connecting helium lines

This manual describes the design, operation and maintenance of the Model 600 / Model 400 helium compressor unit.

1.4 Compatibility

The Oxford Instruments Austin, Inc. Model 600 / Model 400 Helium Compressors are compatible with various coldheads and cryopumps described in the following tables. Each Model 600 / Model 400 compressor unit can be used to run one or more such cryopumps or coldheads. For other combinations than listed below, contact Austin please contact Oxford Instruments Austin, Inc. Technical Support using the contact information found in Chapter 1, Section 1.2.

Table 1-1 Model 600 Helium Compressor Coldhead Compatibility

Model 600 Drive Unit Electrical Circuit Configuration	Coldhead Model (Manufacturer)	Number of Multiple Coldheads Allowed
Scott "T"	350CS (ASC)	3
	1020CS (ASC)	2
	1050CS (ASC)	1
	350CP (CTI)	3
	1020CP (CTI)	2
	1050CP (CTI)	1

Table 1-2 Model 600 Helium Compressor Cryopump Compatibility

Model 600 Drive Unit Electrical Circuit Configuration	Coldhead Model (Manufacturer)	Number of Multiple Coldheads Allowed
Scott "T"	CP8/CP8LP (ASC)	3
	CP10 (ASC)	2
	CP16 (ASC)	1
	CT8/CT8F (CTI)	3
	CT10 (CTI)	2
	CT400	1
	CT500	1
On-board	OB-8/OB-8F (CTI)	3
	OB-10 (CTI)	2
	OB-400 (CTI)	1
	OB-500 (CTI)	1

Table 1-3 Model 400 Helium Compressor Coldhead Compatibility

Model 400 Drive Unit Electrical Circuit Configuration	Coldhead Model (Manufacturer)	Number of Multiple Coldheads Allowed
Scott "T"	350CS (ASC)	2
	1020CS (ASC)	1
	350CP (CTI)	2
	1020CP (CTI)	1

Table 1-4 Model 400 Helium Compressor Cryopump Compatibility

Model 400 Drive Unit Electrical Circuit Configuration	Coldhead Model (Manufacturer)	Number of Multiple Coldheads Allowed
Scott "T"	CP8/CP8LP (ASC)	2
	CP10 (ASC)	1
	CT8/CT8F (CTI)	2
	CT10 (CTI)	1
On-board	OB-8/OB-8F (CTI)	2
	OB-10 (CTI)	1

Additional accessories will be needed to operate multiple cryopumps or coldheads. Refer to Chapter 3, Section 3.3 for the part numbers and ordering information.

2 Safety Warnings

2.1 Standards for the Use of Warnings and Cautions

Warnings are noted when there is a possibility of injury or death to persons operating the equipment or performing specific tasks or procedures noted in this manual.
Cautions are noted when there is a possibility of damage to equipment if the caution is ignored.

2.2 Warnings Applicable to All Aspects of M600 / M400 Operation

2.2.1 High Voltage and Electrical Shock Warnings

Warning: ***Potentially fatal voltages are present in the compressor unit. Before beginning any work on the compressor unit, the compressor needs to be switched off then isolated from the power supply.***

Warning: ***Connect or disconnect the flex lines joining the compressor and its load (cryopump, coldhead, etc.) only after the compressor is switched off and separated from the power source. Otherwise, an electrical shock hazard may exist, causing the compressor unit and its load damage.***

Warning: ***Always provide proper grounding to the compressor unit. All electrical connection and disconnection of the unit should be done by a qualified and licensed electrician.***

Warning: ***High voltage is present within the system and can cause severe injury from electrical shock. Permit only qualified electrical technicians to open any electrical enclosure to perform electrical troubleshooting***

Warning: ***Disconnect the compressor from its power source before carrying out any troubleshooting or maintenance activities.***

2.2.2 High Pressure Related Warnings

Warning: ***High gas pressure is present within the system and can cause severe injury from propelled particles or parts.***

Warning: ***Do not recharge the system without using a pressure regulator.***

2.2.3 Helium Gas-Related Warnings

Warning: ***Helium gas can cause rapid asphyxiation and death if released in a confined and un-ventilated area.***

Warning: ***Use a pressure reducing regulator when withdrawing helium gas from a high pressure cylinder.***

Warning: ***Detaching the helium flex lines when the compressor load is at low temperature may cause the pressure to rise in the system beyond the permissible level therefore creating a safety hazard.***

2.2.4 Heat-Related Warnings

Warning: ***The compressor motor may become hot after operating. Wait for the motor to cool down before working inside the compressor.***

2.3 Operator Instructions

Follow standard Model 600 / Model 400 operating procedures as described in this Manual. If after reading this manual, you still have questions regarding the safe operation of the Model 600 / Model 400 Helium Compressor, please contact Oxford Instruments Austin, Inc. Technical Support using the contact information found in Chapter 1, Section 1.2.

3 Introduction

3.1 General Information about the Model 600 / Model 400 Compressor

Oxford Instruments Austin, Inc. offers industry-proven compressors such as the Model 600 / Model 400 Helium Compressor described in this manual, at highly competitive prices, and with flexible configurations. Model 600 / Model 400 compressors are available in high- and low-voltage configuration and in either air or water-cooled model.

3.1.1 Model 600 / Model 400 Features

The Model 600 / Model 400 compressor is designed for tens of thousands of hours of continuous operation. The main features of the Model 600 / Model 400 compressors are:

- Minimal maintenance requirements
- Removable adsorber panel for easy maintenance
- Integrated water flow meter
- Rack mounting option, which is ideal for vacuum coating/ion implanters, semiconductor vacuum systems, CAT scanners, MRI systems and sputtering system applications.

3.1.2 Overview of Model 600 / Model 400 Compressor Design & Operation

Model 600 / Model 400 Helium Compressor (see Figure 3-1, M600 water-cooled model shown) is designed to run different cryopump or coldhead models from different manufacturers (see Table 3-3 and Table 3-4 for compatibility information), for either high voltage or low-voltage and 60/50 Hz three-phase operations.

The compressor itself consists of five main mechanical components:

- Compressor capsule
- Heat exchanger
- Oil mist (vapor) separator
- Volume tank
- Adsorber

The *compressor unit* and the coldhead are connected by way of helium gas flex lines. The compressor unit, coldhead and helium lines are fitted with self-sealing couplings, and are charged with ultra high-purity (99.999%) helium gas.

The *heat exchanger* removes the heat generated from the process of compressing helium in the capsule. The heat generated by the capsule must be removed from the oil and the helium gas.

To remove heat from the compressor capsule, oil is used as lubrication and cooling medium. The helium gas as well as oil is then pumped by way of differential pressure, out of the capsule through the water-cooled or air-cooled heat exchanger. The cooled oil returns to the capsule to lubricate and cool the capsule.

The *volume tank* is an empty tank that provides additional helium gas volume on the low pressure side of the compressor system. This prevents the low-side pressure from going too low when the compressor is running.

The helium gas purifying occurs after the heat removal and cooling process. Helium gas purification must occur because the heat exchanger still has a small amount of oil vapor mixed with it. If this helium gas gets to the cryopump with oil vapor in it, the oil will freeze and foul the cryopump. The function of the *oil mist (vapor) separator* is to rid the helium gas steam of this oil vapor. The condensate from the oil is then returned to the capsule. The helium gas still contains a small quantity of oil vapor at this point.

The *adsorber* then filters out the remaining oil vapor from the helium gas stream. Overtime, the *adsorber* may become saturated from the oil vapor. Thus, it is important the adsorber be replaced according to the recommended replacement interval.

Figure 3-1 Model 600 Helium Compressor (water-cooled model shown)

3.1.3 Description of Subsystems

Along with the five main components, Table 3-1 describes the subsystems that serve to monitor the operating condition of the compressor unit and to ensure its safe operation.

Table 3-1 Model 600 / Model 400 Helium Compressor Subsystems:

Subsystem Name	Function
Phase rotation monitor	Purpose: Monitors the phase of the input power. Will not allow operation if the phase is incorrect.
Internal line break motor protector	Located in the center of the Y of the motor windings, disconnects all three phases in case of an overload condition. The internal protector protects against single phasing.
Overload relay	Purpose: Monitors system current. Will turn off the compressor if the current level exceeds the preset value.
Thermal switch (TS1)	Purpose: Monitors helium temperature upstream of the heat exchanger. Safety Function: Will turn off the compressor if the helium temperature gets too high.
Thermal Switch (TS2)	Purpose: Monitors helium temperature downstream of the heat exchanger. Safety Function: Will turn off the compressor if the helium temperature gets too high.
Bypass valve	Purpose and Safety Function: Equalizes pressure within the compressor unit upon power interruption.
Oil valve	Purpose and Safety Function: Prevents oil migration when power is off.
Cooling water flow meter (water-cooled model only)	Purpose: Allows a visual reference as to the current flow rate of the cooling water.
Fuses: Fuses for the coldhead drive circuit Fuses for the main input power Fuses for the control voltage Fuses for the fan motors Fuses for the main contactor coil	Safety Function: Over-current protection
Internal relief valve	Purpose and Safety Function: Opens a shunt between the high and low-pressure helium gas circuits. Sets the proper operating pressure for the system regardless of the load. Safety Function: If the differential pressure exceeds a preset value, this valve opens to allow safe operation.
External relief valve	Purpose and Safety Function: Opens the helium gas circuit to atmosphere if the helium gas pressure exceeds 375 PSI.

3.1.4 Operational Flow

The work flow of helium gas within the compressor follows these steps:

1. High-pressure helium gas is delivered from the compressor to the coldhead through the "Supply" helium flex line at 260~280 PSI (M400 – 200-260 PSI).
2. The helium gas is then compressed during the compression stroke of the cryopump.
3. The cryopump then expands the helium gas to expand during its expansion stroke. During this cycle of compression and expansion of the cryopump, the helium gas is forced through regeneration materials to increase the thermodynamic efficiency of the cycle.
4. With each successive cycle, the regeneration material becomes colder and colder. Eventually, the cryopump temperatures come down to cryogenic range.
5. After expansion, the helium gas returns to the compressor through the "Return" helium flex line at 50~100 PSI (M400 – 0-100 PSI) to begin the cycle again.

The helium flow between the Model 600 / Model 400 compressor's components is illustrated in Figure 3-2 and Figure 3-3, for the water-cooled and air-cooled version of the Model 600 / Model 400 compressor, respectively.

Figure 3-2 Flow Diagram for Air-Cooled Model 600 / Model 400 Helium Compressor

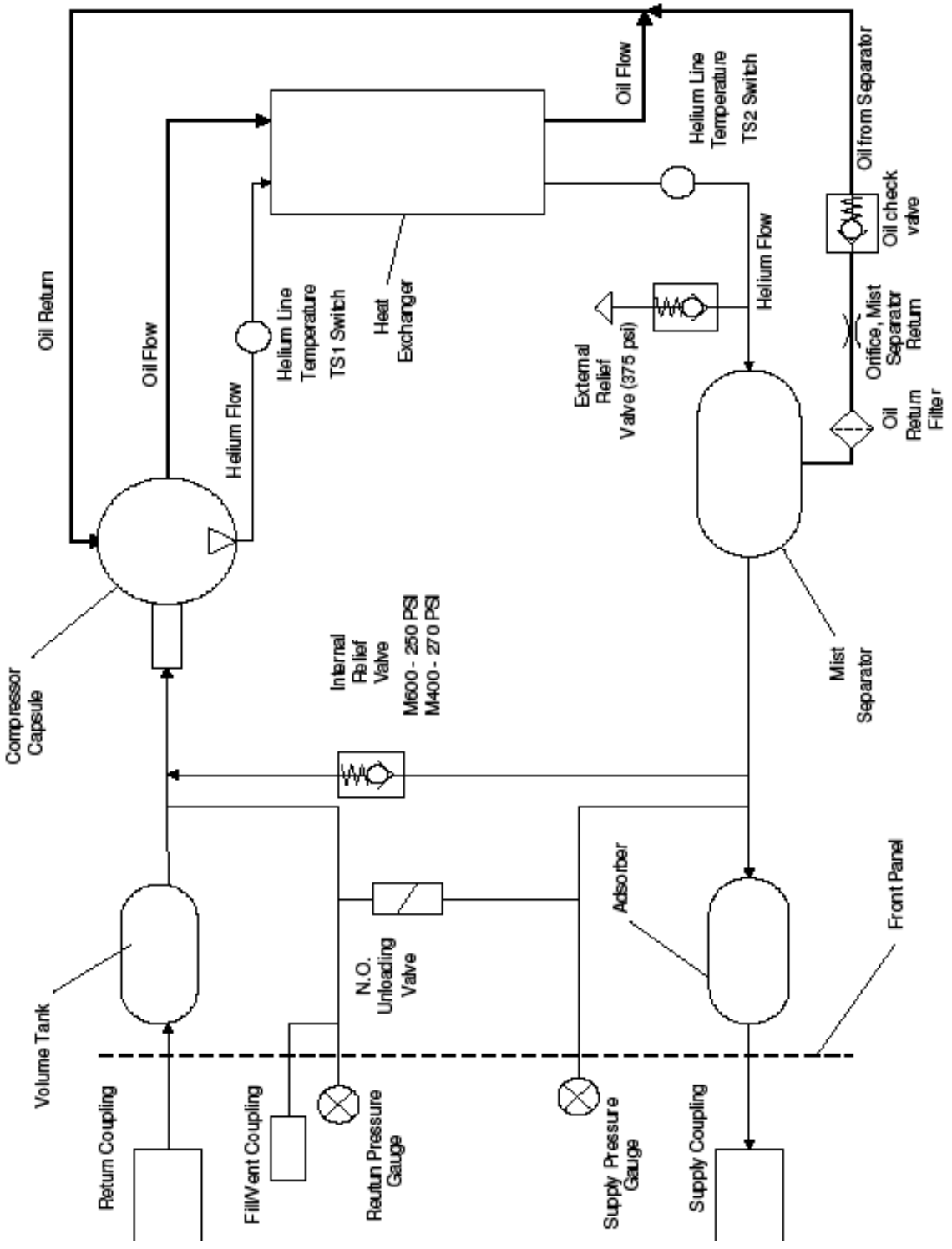
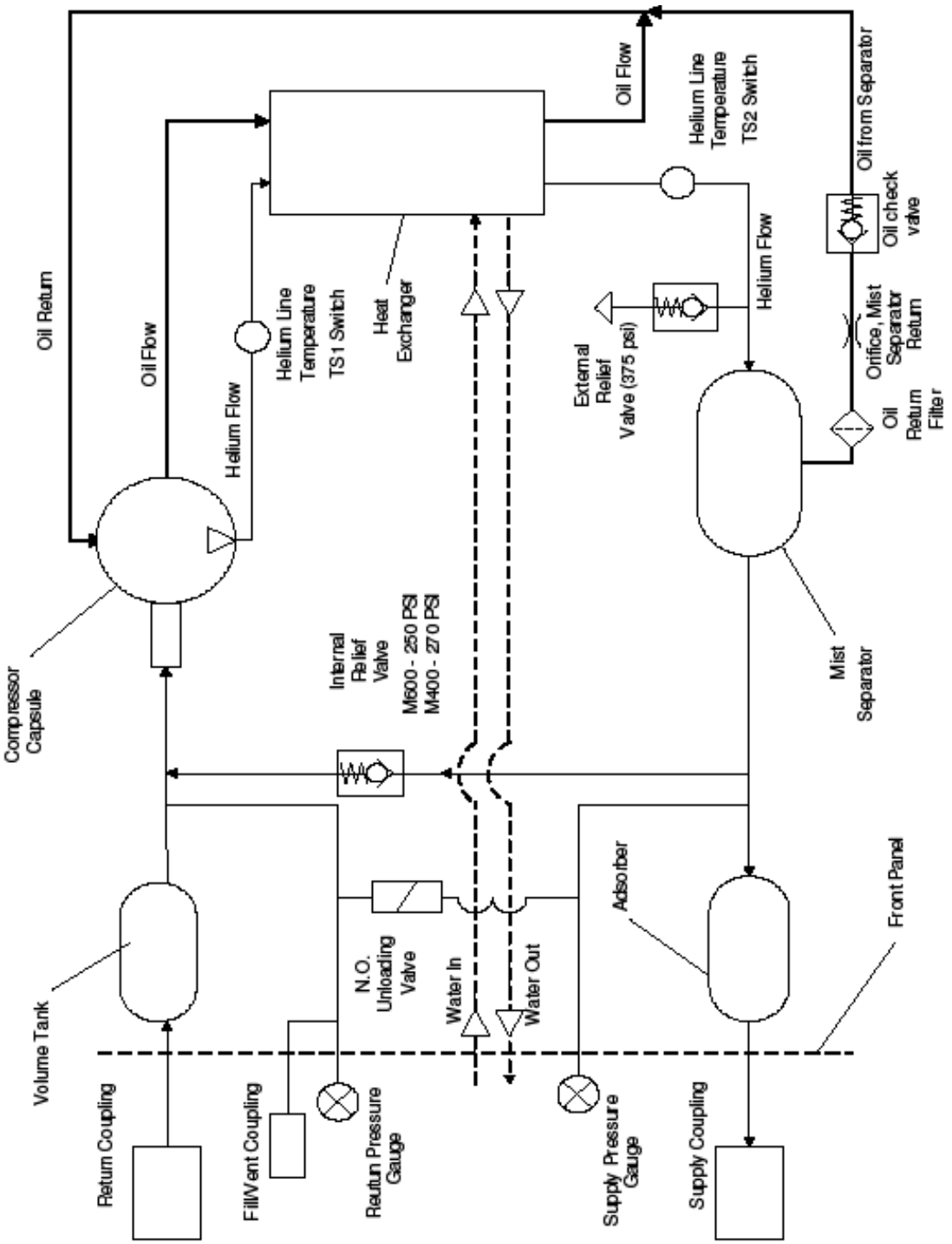


Figure 3-3 Flow Diagram for Water-Cooled Model 600 / Model 400 Helium Compressor



3.2 Specifications

The Model 600 / Model 400 Helium Compressor specifications are listed in Table 3-2 and Table 3-3.

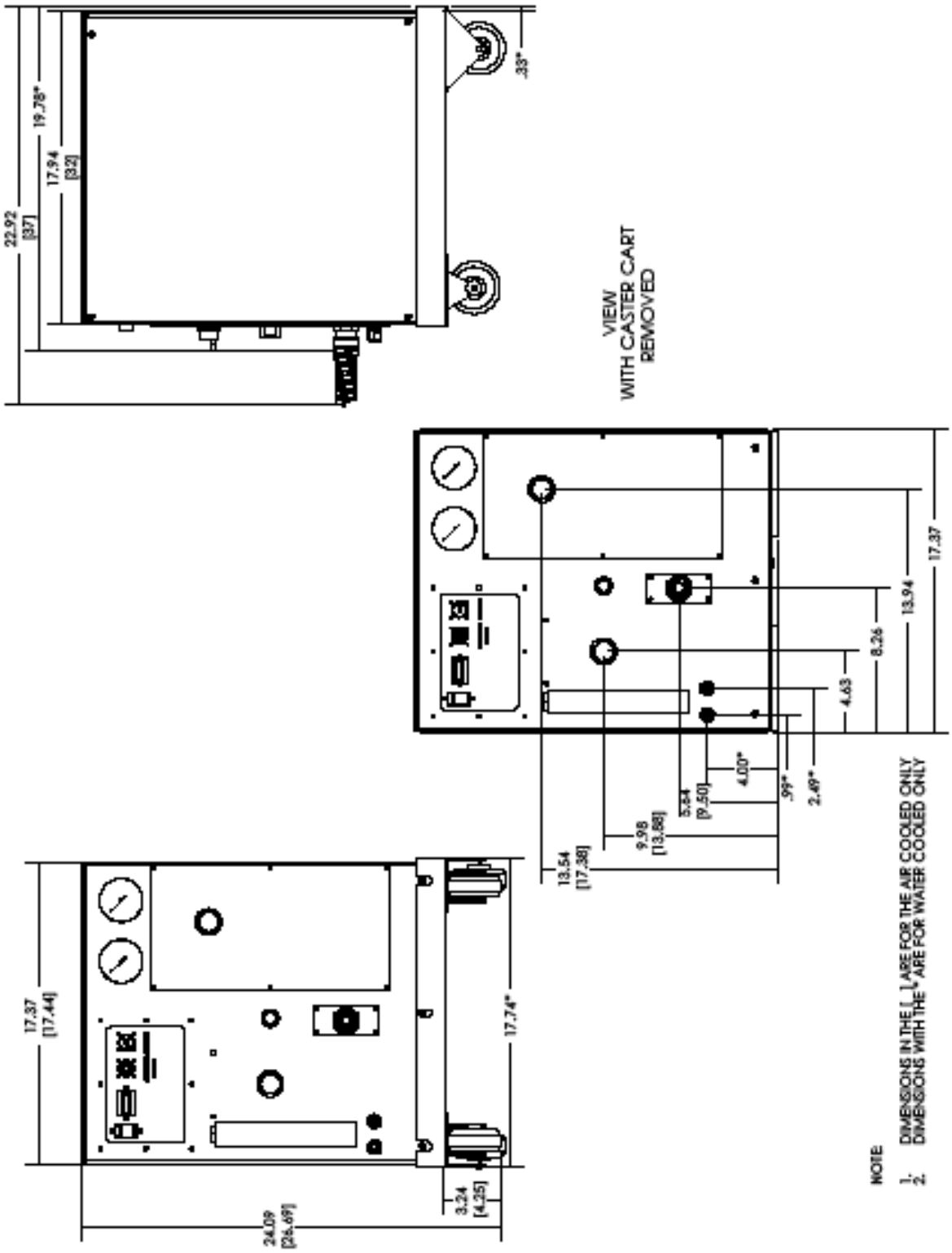
Table 3-2 Power Requirements for Model 600 / Model 400 Helium Compressors

Model	Operating AC Voltage [V] (Factory Setting)	Frequency [Hz]	Phase	Max Current Drawn [A]	Max Power [kW]
Model 600 low voltage (all models)	200~230 +/-10% (230)	60/50	3	25	7.8
Model 600 high voltage (all models)	400~480 +/-10% (480)	60/50	3	13	7.8
Model 400 low voltage (all models)	200~230 +/-10% (230)	60/50	3	21	7.0
Model 400 high voltage (all models)	400~480 +/-10% (480)	60/50	3	9	7.0

Table 3-3 Model 600 / Model 400 Helium Compressor Specifications

Feature/Component	Specification Description
Physical Dimensions	See Fig. 3-4
Weight	260 lbs for water-cooled model 300 lbs for air-cooled model
Helium Pressure	Static: 240 +/- 5 psig Operating Delta P: 250 +/- 10 psig (M600) 270 +/- 10 psig (M400)
Interface	Cold head power connector mates with ASC and CTI drive cables Compressor power cord is equipped with bare ends Helium connections: 1/2 inch male Aeroquip couplings
Adsorber Replacement Schedule	15,000 Hours (per elapsed time meter on the compressor) or 3 years. Which ever comes first.
Cooling Water (for water-cooled models)	1.4 -1.8 GPM minimum flow rate 65° F~80° F maximum inlet water temperature Recommended chiller capacity: M600 – 2.5 ton/per unit M400 – 2.0 ton/per unit Water line connector: 3/8 inch Swagelok Tube Fittings
Air Cooling (for air-cooled models)	Air-cooled units must maintain a minimum clearance of at least 24 inches at all sides Maximum ambient temperature should not exceed 104° F

Figure 3-4 Models 600 / Model 400 Dimensions



3.3 Ordering Information

Table 3-4 contains the ordering information for the Model 600 / Model 400 compressor unit.

Table 3-4 Model 600 / Model 400 Helium Compressor Ordering Information

Compressor Configuration	Part Number
M600 air-cooled, high voltage, standard drive circuit	91-00009-001
M600 air-cooled, low voltage, standard drive circuit	91-00009-000
M600 air-cooled, low voltage, Onboard drive circuit	91-00010-000
M600 water-cooled, high voltage, standard drive circuit	91-00014-000
M600 water-cooled, low voltage, standard drive circuit	91-00014-001
M600 water-cooled, low voltage, Onboard drive circuit	91-00015-000
M400 air-cooled, high voltage, standard drive circuit	91-00007-000
M400 air-cooled, low voltage, standard drive circuit	91-00007-001
M400 air-cooled, low voltage, Onboard drive circuit	91-00013-001
M400 water-cooled, high voltage, standard drive circuit	91-00016-000
M400 water-cooled, low voltage, standard drive circuit	91-00016-001
M400 water-cooled, low voltage, Onboard drive circuit	91-00017-000

Customers can also order the optional accessories and replacement parts listed in Table 3-5.

Table 3-5 Optional Accessories and Replacement Parts

Accessories/Replacement Parts	Part Number
Adsorber	80-00005-000
Helium charge line (10ft.*), with bleeder fitting	10346
Helium regulator	HR-580
Helium lines (10ft.*)	10418-10
Helium tee, for connecting two cryopumps	T-MMF
Three-port manifold, for connecting three cryopumps	80075
Splitter box, supplies power to up to three cryopumps	10359
Onboard splitter box, supplies power to up to three Onboard cryopumps	10366
Maintenance manifold, for helium clean up process on compressors and cryopumps	10134
Cryopump drive cable (10ft.*), sends power to the cryopump motor from the compressor	10144-10

*Custom length available.

4 Installation

4.1 Safety Warnings

Review the safety warnings in Chapter 2 before beginning any installation activities.

4.2 Installation Steps

4.2.1 Unpacking and Inspection

Once the equipment is received, inspect the exterior of the shipping carton for any signs of damage. Report any damage to the shipping company immediately.

Remove the straps and packaging materials on the compressor unit, then lift or roll the unit out of the carton carefully. Inspect the exterior of the unit. If any damage is observed, inform the shipping company. Keep the original packaging materials in case the unit needs to be returned to the factory for service or other reasons.

Most shipping companies have a certain grace period for reporting damages due to shipping in order to process the insurance information in a timely manner. Therefore it is highly recommended that shipping carton be opened and the unit inspected whether or not it will be put into operation right away.

Caution: ***When transporting or storing the compressor unit, make certain it is not tilted by more than 45 degrees to avoid the unit been tipped over.***

4.2.2 Mounting the Compressor

It is highly recommended that the compressor unit be installed on a level and steady surface.

If the unit must be installed in a tilted manner, the maximum tilting angle is 10 degrees. Tilting the unit more than this maximum allowable angle could result in damage and contamination in the system, and may void the warranty on the unit.

4.2.3 Preparing the Compressor for Operation

1. Check the voltage of the power source before connecting the main power cable to a suitable connector or disconnect box, making sure that the compressor switch is off. *If the voltage of the power source is different from the factory default setting (see Chapter 3, Table 3-2), it may be necessary to change the tap settings on the 24VAC control transformer located inside the electrical box of the compressor. Follow the steps described in Section 4.2.5 to make the change.*
2. For water-cooled Model 600 / Model 400 units, connect the cooling water:
    a. Typical municipal drinking water is acceptable, however, a closed loop chilled water source is recommended.
    b. Minimum water flow rate of 1.4 - 1.8 GPM is required to achieve a maximum discharge temperature of 100 °F (with 80°F considered ideal)
3. For air-cooled Model 600 / Model 400 units, make sure the front and rear grills have at least 24 inches of clearance from the nearest objects at all sides.
4. Verify that helium pressure is between 240 +/- 5 psig. If pressure is low, refer to Chapter 7, Section 7.4.1for charging procedures.
5. Start the compressor and run for about 15 minutes to stabilize the compressor oil inventory.
6. The compressor is now ready to be connected to the cryopump or coldhead.

4.2.4 Installation

4.2.4.1 Ambient Conditions and Coolant Connection

Ambient Conditions:

When the compressor is in operation, the ambient temperature should be between 5°C to 40°C (40°F to 104°F). The compressor unit should be set up in a non-condensing environment.

Coolant Connection:

Caution: ***For water-cooled compressor models, the water used in the unit operation must meet the specifications indicated in Chapter 3, Section 3.2.***

Caution: ***Failure to comply with the coolant specifications may result in serious damage to the compressor and may void the warranty on the unit.***

Identify the inlet and outlet connection ports first before connecting the hoses. The water supply line should be connected to the inlet port on the compressor.

An in-line water particulate filter is recommended to prevent heat exchanger fouling.

Periodically check the coolant flow rate and temperature to ensure the proper operation of the compressor unit.

4.2.4.2 Connecting the Helium Flex Lines

Caution: ***Attach or detach the helium flex lines only when the power to the compressor unit is switched off. Never twist the helium flex lines during the installation process.***

Before connecting the helium flex lines, follow these steps:

1. Identify the helium "Return" (low pressure) and "Supply" (high pressure) ports on the compressor front panel.
2. Clearly mark the helium flex line that will be used to connect to the corresponding "Supply" and "Return" port on the cryopump or coldhead,

Note: ***The helium flex lines are equipped with self-sealing couplings which can be attached and detached without helium escaping.***

Follow these steps to connect the helium flex lines:

1. Unscrew the protective caps from the couplings and keep the caps for future use.
2. Check the connectors for cleanness. When necessary, use lint-free clean cloth or soft brush to clean the connectors.
3. Check the flat seals on the male couplings and make sure they are properly placed. Replace any missing or defective seals.
4. Use only the open-wrenches supplied with the installation kit. For a ½" coupling, tighten with a 1-3/16" wrench and stabilize with a 1" wrench.
5. Tighten down all couplings as far as possible and then back off by one quarter turn to relieve strain.

If the flex lines need to be bent to a radii of less than 8" (20 cm), then a 90 degree helium elbow needs to be installed (Chapter 3, Section 3.3 for the part number).

4.2.4.3 Filling the Compressor with Helium Gas

Caution: ***All safety regulations related to handling pressurized gas cylinders must be observed. Only use helium with 99.999% or better purity when performing refill operation.***

Follow these steps:

1. Connect a pressure reducer and a helium flex line to a helium supply gas cylinder
2. Connect the open end of the helium flex line to the helium gas charge/vent valve on the rear panel of the unit, do not tighten the 1/4" flare connector on the end of the flex line
3. Open the valve at the cylinder
4. Set the pressure of the helium supply cylinder to the value specified in Chapter 3, Table 3-3. Open the pressure regulator valve slightly so that the helium flex line is purged with helium gas for at least 15 seconds.
5. Tighten the 1/4" female Aeroquip fitting on the end of the helium charge line to the gas Fill/Vent Aeroquip fitting of the compressor
6. Open the helium gas Fill/Vent fitting and fill the compressor unit to the desired pressure value.
7. Detach the coupling of the helium charge line from the helium charge/vent valve.
8. Close the helium gas regulator on the supply cylinder.
9. Seal the helium gas Fill/Vent fitting on the compressor unit by properly securing with a protective cap.

4.2.4.4 Adjusting Helium Gas Pressure

Refer to Chapter 3, Table 3-3 for the required pressure specification of the compressor unit. If the pressure falls below that level, the helium gas refill procedure described in Section 4.2.4.3 to be performed. On the other hand, if the pressure is too high, then the helium gas needs to be released in order to maintain the proper level.

4.2.5 Electrical Connection

Caution: ***Before connecting power to the compressor unit, make sure the factory setting of the operating voltage matches that of the power supply where the unit is being installed. Failure to do so will result in performance degradation of the system.***

If the voltage of the power source is different from the factory default setting (see Chapter 3, Table 3-2), it will be necessary to change the tap settings on the 24VAC control transformer located inside the electrical box of the compressor. Follow the steps described below to make the change:

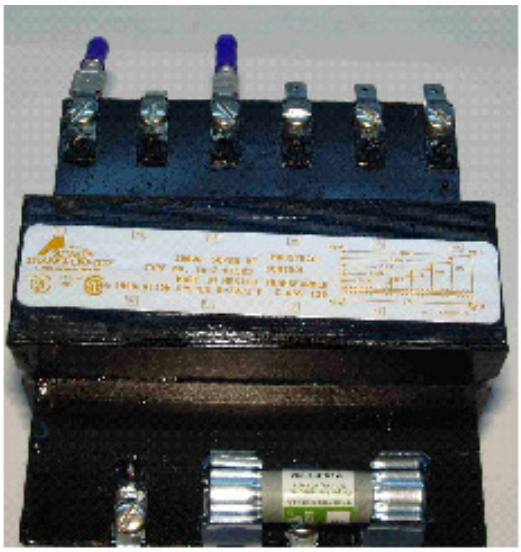
1. Unscrew the two side panels of the compressor
2. Unscrew the top (wrap-around) cover of the unit
3. Unscrew the electrical box cover
4. Change taps on the 24VAC control transformer to the setting that is closest to that of the power source (illustrated in Figure 4-1)
5. Put back and screw down the electrical box cover
6. Put back and screw down the panels and top cover of the compressor

Electrical connections are to be made in accordance with the diagram in Figure 4-2 high voltage Model 600 / Model 400 compressor series, and the diagram in Figure 4-3 for low voltage models.

Figure 4-1 Model 600 / Model 400 Helium Compressor Control Voltage Transformer Tap Settings

208/220V Setting

240V Setting
(Factory setting for low voltage models)



380/400V Setting

460/480V Setting
(Factory setting for high voltage models)

5 Operations

5.1 Before Switching On the System

After the compressor unit and its load (cryopump, coldhead, etc.) are installed and connected, check the helium gas pressure as indicated by the pressure gauge mounted on the rear panel of the compressor unit. Refer to Chapter 3, Section 3.2, for the proper static pressure readings for the compressor.

If the helium pressure needs to be adjusted, refer to Chapter 7, Section 7.4.1 for procedures to release helium gas in order to reduce the pressure or to fill the compressor with more helium gas to increase the pressure.

5.2 Normal Operation

The load of the compressor can be powered through the power connectors located on the front panel of the compressor. To start operation of the compressor and its load, do the following:

1. Open the coolant supply (water-cooled compressor model only)
2. Switch on the main power source
3. Press the ON button to start the compressor. Both the compressor and its load should start simultaneously

Note: ***During initial start-up, the compressor internal relief valve may begin to "Chatter". This is a normal occurrence and should subside within a few minutes.***

During operation, check the coolant flow rate (water-cooled compressor) and the operating pressure frequently. Refer to Chapter 3, Table 3-3 for required coolant flow rate. If it is too slow, make sure any problems associated with water supply or water outlet are resolved. Refer to Chapter 3, Table 3-3 for proper helium pressure level for the compressor unit. If the helium pressure is too low, switch off the compressor unit. It may be necessary to perform a helium "topping-up" maintenance procedure as described in Chapter 7, Section 7.4.1. If pressure drop-off happens frequently, there may be a substantial leak in the helium circuit of the compressor. In this case, contact Oxford Instruments Austin, Inc. customer service immediately.

To shut down the compressor unit, press the OFF button on the front panel. After that, allow coolant to continue to circulate for at least 10 more minutes before shutting off flow.

5.2.1 Cycle Times

There is no set answer to how often the cryogenic compressor can be started and stopped in an hour. Oxford Instruments Austin, Inc. recommends a maximum of twelve cycles per hour. One critical consideration is a minimum run time required to return oil to the compressor after start up. To assure proper oil return, one minute is the minimum run time for all cryogenic compressors. A second consideration is a four minute minimum off cycle time once the compressor cycles off.

5.3 Electronics Interface Connections

5.3.1 J1 Remote Interface

The Model 600 / Model 400 Compressor provide a D-sub 25 connector for remote interface control and status collection.

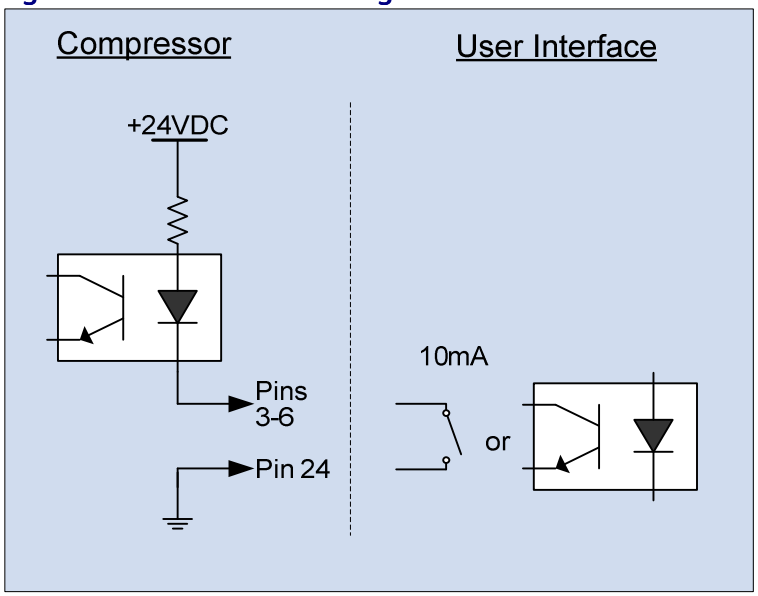
Table 5-1 J1 Remote Connector (25-pin D-sub)

Pin Number	Assignment	Pin Number	Assignment
1	No Connect	14	No Connect
2	No Connect	15	No Connect
3	Reset	16	Pressure Alarm
4	Cold Head ON/OFF	17	Phase Error
5	No Connect	18	Temp Alarm
6	Compressor ON/OFF	19	Run Status (Compressor ON = '1')
7	No Connect	20	No Connect
8	No Connect	21	No Connect
9	No Connect	22	No Connect
10	No Connect	23	No Connect
11	No Connect	24	Ground
12	No Connect	25	+24V Output
13	No Connect		

5.3.2 D-sub User Controls

The Model 600 / Model 400 Compressor input control signals (pins 3, 4, 6) require a user slide switch or opto-coupler as shown in the figure below.

Figure 5-1 User Control Signal Interface

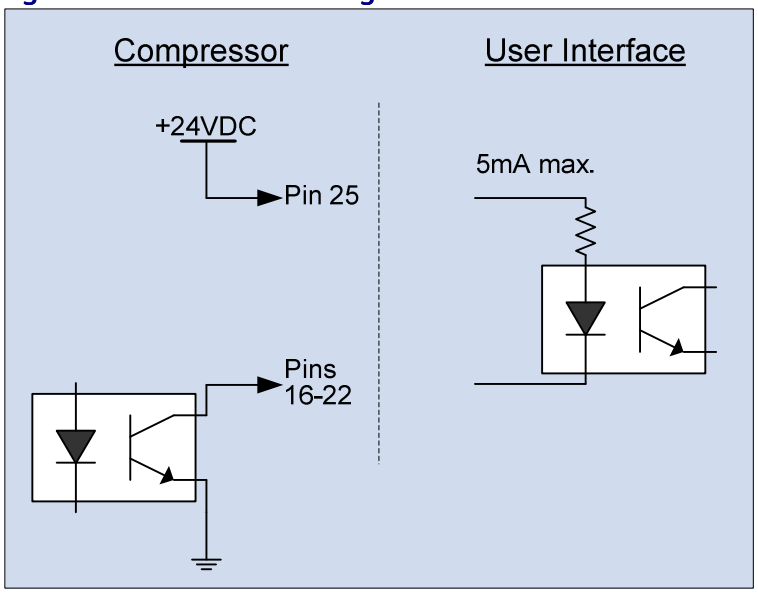


Example: To start the compressor connect pin 6 to pin 24. To start the coldhead, connect pin 4 to pin 24.

5.3.3 D-sub User Status

The Model 600 / Model 400 Compressor output status signals (pins 16-19) are designed to drive a user side opto-coupler as shown in the figure below.

Figure 5-2 User Status Signal Interface



Example: Use the output voltage from pin 19 & 25 to monitor the run status of the compressor, this output can be used to drive a LED or used as an input to a PLC.

5.3.4 Compressor Front Panel User Interface

On start-up, the Model 600 / Model 400 Compressor front panel LCD will display the title screen and revision information. Once initialization is complete, the main screen is displayed.

Note:

If the phases are not connected properly, a "Phase Error" will be displayed. The compressor cannot be started until the unit is powered down and the phase error is corrected.

The compressor provides 3 buttons and a 2-line display for easy operation:

- Off
- On
- Menu

Pressing the "Off" button from any screen results in powering the compressor off. The unit can only be turned on if all operational checks are passed. If a system error occurs, pressing the "Menu" button displays the status of each system check. If all operational checks are successful, pressing the "Menu" button displays the operating hours on the compressor.

The "On" button powers the compressor if all system checks are successful. If a system check is in the failed state, the "On" button is ignored.

5.3.5 Compressor Operational Checks

Table 5-2 Operational Checks

System Interlock	Fault
Helium Pressure Alarm	Pressure alarm contact is not OPEN. Verify pressure contact.
Helium Temperature Alarm	Temperature alarm contact is not OPEN. Verify temperature contact.
Contactor Alarm	Contractor overload tripped.

5.3.6 Compressor System Shut Down

Manual shut-down

Push the OFF button

Automatic shut-down

The following system indication will cause the compressor to automatically shut down:

1. Low Helium pressure
2. High Helium temperature
3. Contactor Overload

If an automatic shut down occurs, refer to Chapter 5, Table 5-2 to identify and remove the fault. Once the fault has been corrected, the user can restart the system by pressing the "ON" button.

5.3.7 Compressor Interfaces

5.3.7.1 Serial Port Interface

The Model 600 / Model 400 Compressor provide a DB9 Male connector for serial port communications. A "straight through" serial cable, as shown in the table below, is necessary for interfacing to the serial port. Only pins 2, 3, and 5 are required.

Table 5-3 Serial Port Interface (J2 RS232)

Pin Assignment		
DB9 Female (to Compressor)		DB9 (to Controller)
1	----------	1
2(TxD)	----------	2(RxD)
3(RxD)	----------	3(TxD)
4	----------	4
5(Gnd)	----------	5(Gnd)
6	----------	6
7	----------	7
8	----------	8
9	----------	9

5.3.8 Serial Port Cable

Table 5-4 Serial Port Settings

Baud Rate	4800
Data Bits	8
Parity	NONE
Start Bits	1
Stop Bits	NONE

5.3.9 Communications

- No handshaking
- PC is always the host.
- Commands and data requests from host.
- Message Format:
    - Byte 1: STX (02h = control-B)
    - Bytes 2..4 Command or data request
    - Bytes 5..X Command or requested data
    - Byte X+1 (Carriage Return = 0Dh)
- All bytes are ASCII type (20h..7Fh)
- Maximum value for X is 126.
- Individual data values are separated by a forward slash
- Used letters are ASCII capitals.
- Used numbers are ASCII decimals.
- Incorrect formats are ignored

5.3.9.1 Serial Port Commands

The following serial port commands are provided:

Table 5-5 Serial Port Commands

Command Message		
Command	**No. of Bytes**	**Description**
Send: STX SYS1 CR	1+4+1	Turn System On
Receive: STX SYS2 CR	1+4+1	System Error

Table 5-6 Data Message

Command	No. of Bytes	Description
Send: STX DAT CR	1+3+1	Data request
Receive:		
STX DAT	1+3	
0.00	4+1	SW Version
000000	6+1	Reserved
12345	5+1	Hours Counter
000000000000000	15	Reserved
003	3+1	On Timer(seconds)
1	1+1	Status: 0 = Off
1	1+1	1 = On 2 = System Error
0000	4	
00	2+1	Compressor Status: 0 = Off
1000000000000000	16+1	1 = On
4	1	Reserved
CR		Number of active errors 1 = active error 0 = error inactive Number of errors logged (≤ 8) End of message

Table 5-7 Command/Data

Send	Compressor	Description
STX SYS x CR	STX SYS y CR	X = Y = 0 Off X = Y = 1 On Y = 2 System Error
STX SC x y CR	STX SC x y CR	X = 1 Cold Head Y = 1 On Y= 0 Off
STX DAT CR	As described in previous table	Data Requested
STX ERR CR	STX ERR xx hhhhh / xx hhhhh / xx hhhhh CR (Will display last 8 error codes)	xx = error code hhhhh = hours counter

Example:
STX SYS1 CR Turns the compressor on, The system will respond with SYS1
STX SYS0 Turns the compressor off

SXT 11 CR = Coldhead On the compressor will return SC11
Note the compressor must be running to turn the Coldhead on.

Table 5-8 Error Codes

Error Code	Display	Description
1	System Error	Error has occurred
2-3		Reserved
4	Contactor Error	Compressor overload relay has tripped off.
5	Phase/Fuse Error	Line voltage out of Phase. Fuses blown
6	Pressure Alarm	Low pressure switch tripped
7	Temperature Fail	Thermal Switch has tripped Coolant Supply Failure Lack of cooling
8-16		Reserved

6 Troubleshooting

6.1 Troubleshooting Activities

Table 6-1 describes some problems that users might encounter while operating the Model 600 / Model 400 Helium Compressor and provides solutions to those problems. Additional troubleshooting information can be found in Chapter 5, Table 5-8.

If a compressor problem still persists after performing the corrective actions described in this section, please contact Oxford Instruments Austin, Inc. Technical Support for further assistance. Refer to Chapter 1, Section 1.2 for contact information.

Table 6-1 Troubleshooting Procedures

Problem	Possible Cause	Corrective Action
The compressor On/Off switch (SW1) is in the On position but will not start.	1. No power is coming from the power source. 2. Incorrect or disconnected wiring within the compressor 3. Thermal protection switch (TS1 and/or TS2) is open. 4. High current has tripped the current overload relay. 5. The LCD display goes out when the start button is pressed.	1. Check service fuses, circuit breakers, and wiring associated with the power source. Repair as needed. 2. Check the compressor wiring against the wiring schematic. See Chapter 4, Figure 4-2 or Figure 4-3. 3. Confirm that switch TS1 and/or TS2 is closed. The compressor will display over temperature on the status menu. 4. Reset the current overload relay. 5. Check for the proper transformer wiring figure 4.1
Compressor stops after several minutes of operation and remains off.	1. High temperature of the compressor caused by insufficient cooling water (for water-cooled model), resulting in the opening of thermal protection switches (TS1 and/or TS2). For air-cooled model, the ambient temperature is too high. 2. Insufficient helium static pressure. 3. High temperature helium gas tripped the thermal protection switch (TS1). 4. Low power source voltage. 5. Mechanical seizure.	1. Confirm that sufficient cooling water (for water-cooled model) is flowing to the compressor. For air-cooled model, provide additional cooling to the surrounding environment. 2. Add helium, using the procedures described in Chapter 7, Section 7.4.1. 3. Check for proper cooling of the compressor unit. 4. Confirm that power source voltage is correct. 5. Contact Oxford Instruments Austin, Inc. for assistance.

7 Maintenance

7.1 Maintenance Personnel Requirements

Only trained and qualified personnel should perform the maintenance procedures described in this chapter. All other maintenance work must be performed by Oxford Instruments Austin, Inc. personnel in the factory. Please contact Oxford Instruments Austin, Inc. to make arrangement for such work. See contact information in Chapter 1, Section 1.2.

7.2 Removing the Compressor from Service: Removal, Transport, and Storage

It is recommended that the Model 600 / Model 400 compressor be removed from service when carrying out the maintenance duties described in Chapter 7, Section 7.3.

To remove the compressor unit from service, do the following:

1. Turn off the compressor unit by pressing the OFF button
2. Switch off the main power supply to the compressor
3. Separate the compressor unit from the main power source
4. Allow coolant to continue circulate for at least 10 more minutes (for water-cooled model)
5. Allow the compressor load (cryopump, coldhead, etc.) to warm up before detaching helium flex lines

Caution: ***Loosening or detaching helium flex lines with the compressor load at low temperature without proper warming-up can result in loss of helium and/or pressure rise in the compressor unit beyond its designed maximum pressure level.***

When transporting the compressor unit, follow these guidelines:

- Make sure the appropriate protective caps are properly secured before shipping.
- Always store the compressor unit in a dry place. Refer to Chapter 3, Table 3-3 for proper storage environment.
- If a freezing temperature environment is anticipated whether during shipping or under storage, make certain the coolant in the compressor circuit is properly drained.

Caution: ***The compressor unit should never be tilted more than 45 degrees either during shipping or in storage.***

7.3 Scheduled Preventative Maintenance Activity

The only scheduled maintenance required on the Model 600 / Model 400 compressor is the replacement of compressor adsorber after every 15,000 hours of operation as indicated on the compressor elapsed time meter or 3 years, which ever comes first

The adsorber is used to keep the oil vapor out of the helium gas in the flow circuit of compressor unit and its load. After about 15,000 hours of operation or 3 years, the effectiveness of the adsorber will decrease. It will then need to be replaced. Otherwise the oil particles could accumulate on the cold surface of the compressor load, reducing the cooling performance of the overall system. In severe cases of such oil contamination, the load (cryopump, coldhead, etc.) could cease to function completely.

To remove and replace the compressor adsorber, follow the steps described in Chapter 7, Section 7.3.1 and Chapter 7, Section 7.3.2.

Caution: ***Use only Oxford Instruments Austin, Inc. supplied adsorber for replacement. Refer to Chapter 3, Section 3.3 for the part number.***

7.3.1 Remove the Compressor Adsorber

To remove the compressor adsorber:

1. Turn off the compressor and separate it from the main power supply.
2. Allow sufficient time for the load of the compressor (cryopump or coldhead) to warm up before detaching the helium flex lines from the compressor. Refer to Chapter 4, Section 4.2 for proper procedures to detach helium flex lines.

Caution: ***Detaching helium flex lines with the compressor load at low temperature could result in loss of helium gas. It may also cause the pressure rise in the system beyond the permissible level therefore creating a safety hazard.***

3. Use the two wrenches supplied with the (optional) Installation Kit to avoid loosening the body of the coupling from its adapter. Hold one wrench tight on the coupling half attached to the rear side of the compressor. Use the other wrench to loosen the coupling to the helium supply line.
4. Unscrew the two-self sealing coupling halves quickly to minimize minor gas leakage. Figure 7-9 contains an illustration of the self-sealing couplings.
5. Detach the helium flex line from the helium supply connection located on the adsorber panel on the front panel. See Figure 7-1.
6. Unscrew and remove the nut and washer of the helium supply connector.
7. Unscrew the six screws holding the adsorber panel on the front panel, as illustrated in Figure 7-2.
8. Once the adsorber panel is removed, the adsorber should be in full view. Remove the two screws that hold the adsorber to the bottom of the compressor chassis, as illustrated in Figure 7-3 and Figure 7-4.

9. There is a short section of helium flex line that connects the adsorber with the oil-mist separator of the compressor. Unscrew the connection. See Figure 7-5.
10. Slightly pull the adsorber assembly towards the front. Then tilt the assembly to remove it from the chassis, as illustrated in Figure 7-6.
11. Remove the adsorber and save all nuts, bolts, and washers for installing the replacement adsorber (Figure 7-7 and Figure 7-8).
12. The removed adsorber can be returned to Oxford Instruments Austin, Inc. for credit. Chapter 1, Section 1.2 provides the contact information.

7.3.2 Install Replacement Adsorber

To install the replacement adsorber:

1. Remove the dust caps from the self-sealing coupling halves at each end of the replacement adsorber.
2. Check the self-sealing connector flat rubber gasket to make sure that it is clean and properly positioned.
3. Place the adsorber back in the compressor using the nuts, bolts, and washers set aside during the removal process described in Step 5 of Chapter 7, Section 7.3.1.
4. Install the two-self sealing coupling halves quickly to minimize minor gas leakage.
5. Use the two wrenches supplied with the (optional) Installation Kit, holding one wrench tight on the coupling half attached to the rear side of the compressor. Use the other wrench to tighten the coupling to the helium supply line.
6. Make the final turns by hand and then use the wrenches until the fittings bottom out.
7. Replace the adsorber panel and the flex lines.
8. Make sure the supply pressure gauge reads 240 +/- 5 psig. If the pressure is either too high or too low, follow the instructions in Chapter 7, Section 7.4.1 to fill the helium gas to the proper pressure level.
9. Add 15,000 to the reading of the elapsed time meter and write this number on the decal provided with the replacement adsorber. This decal can be affixed to the foot of the compressor.
10. Restart the compressor.

Figure 7.1 Step 1

Figure 7.2 Step 2

Figure 7.3 Step 3 (a)

Figure 7.4 Step 3 (b)

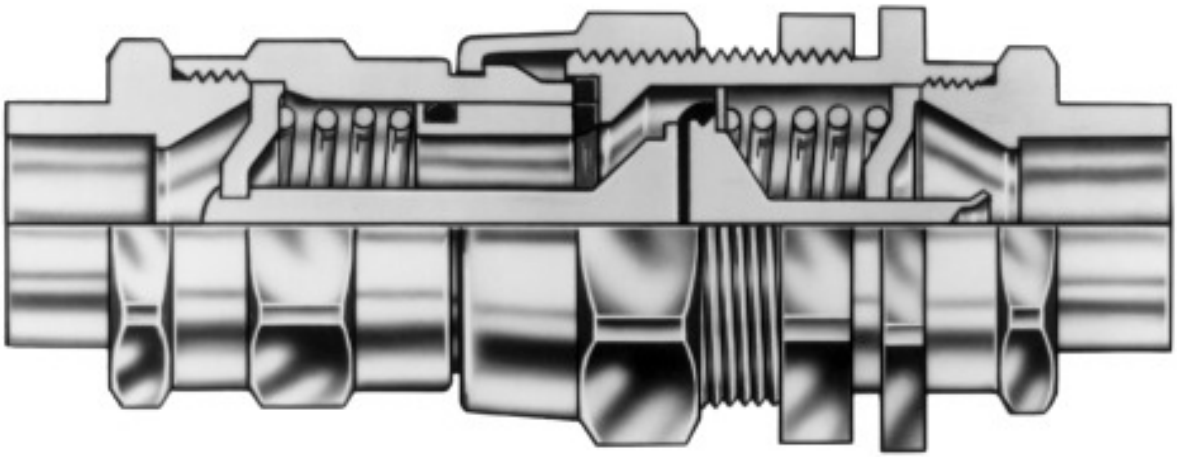
Figure 7-5 Step 4

Figure 7-6 Step 5

Figure 7-7 Step 6 (a)

Figure 7-8 Step 6 (b)

Figure 7-9 Model 600 / Model 400 Self-Sealing Coupling in Closed Position



7.4 Unscheduled Corrective Maintenance

The following corrective maintenance activities may be necessary should the helium gas circuit of Model 600 / Model 400 compressor becomes contaminated.

7.4.1 Adding Helium Gas

If a compressor unit needs to have helium gas added more than once every several months, check for leaks caused by improperly connected self-sealing connections or incorrectly sealed charge valve. If the compressor unit is connected to its load (cryopump, coldhead, etc.), check for leaks in the load also.

Use only 99.999% pure helium gas.

To add helium gas:

1. Remove the Aeroquip cap of the Helium Fill/Vent fitting on the front of the compressor.
2. A user-supplied helium charge line terminating in a 1/4 inch female Aeroquip fitting and a pressure regulator rated at 400 psig delivery pressure is required.
3. Set the helium pressure regulator to 10 to 25 psig. Allow helium gas to flow through the charging female Aeroquip fitting for 30 seconds to purge the charge line of air. Then tighten the flare nut at the end of the charge line.
4. Loosely attaching a charge line from the helium pressure regulator on the helium pressure bottle to the 1/4 inch male Aeroquip fitting installed on the helium Fill/Vent fitting.
    a. If the compressor has been running under normal operating conditions and is up to operating temperature, set the helium pressure regulator to 325 psig and slowly open the helium charge valve on the regulator. When the helium supply pressure gauge rises to 250 to 260 psig, tightly close the charger valve.
    b. If the compressor is not running, set the helium pressure regulator to 250 psig and slowly open the helium charge valve. When the helium supply pressure gauge rises to 240 +/-5 psig, tightly close the charge valve.
5. Insure that the helium charge valve on the regulator is tightly closed. Then shut off the helium pressure regulator on the helium bottle. Remove the charge line from the male Aeroquip fitting and reinstall the cap.

7.4.2 Removing Helium Contamination

Helium contamination is usually indicated by irregular, noisy or intermittent operation (ratcheting), and sometimes seizure of the cryopump drive mechanism. This is caused by accumulation of frozen contaminants within the compressor load and resulting in interference. The source of the helium contamination is due to either

- Inadvertent introduction of ambient air into the system
- Use of helium with purity of less than 99.999%, such as helium gas used for leak detection and welding.

Steps to decontaminate the helium circuit:

Minor contamination can usually be removed by running the cryopump for several hours to trap contaminants in the cryopump, then shut down the compressor and immediately remove the helium lines at the compressor. Allow the cryopump to warm thoroughly, and then perform the helium cleanup procedure as outlined in the cryopump manual.

7.5 Cleaning Equipment

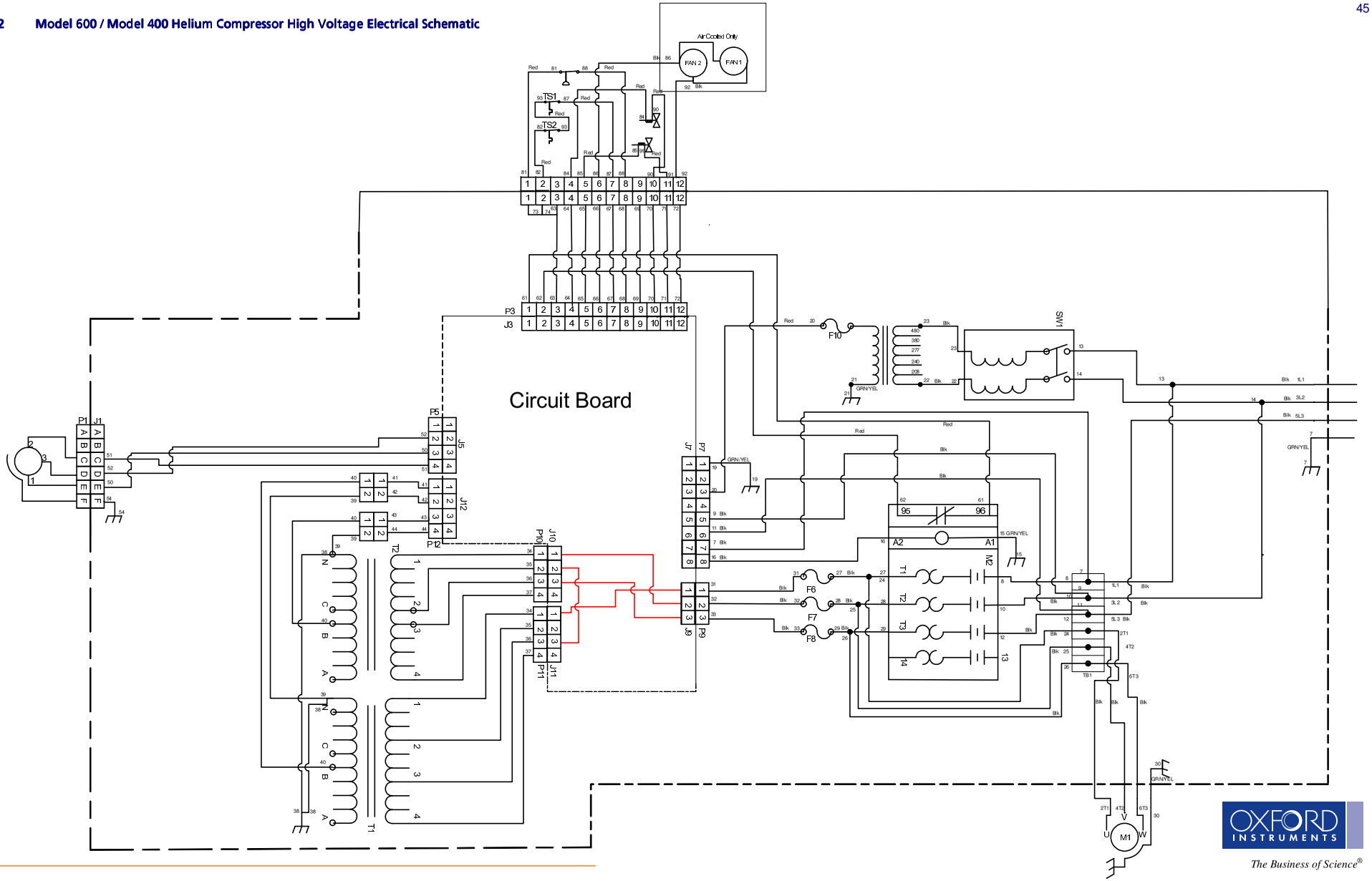
Stubborn contamination involving water vapor requires decontamination of the compressor. One effective method involves supplying clean helium to the return side at appropriate pressure while venting a small amount of gas from the supply side; while the compressor is running. This is referred to as a "Running Purge". Contact Oxford Instruments Austin, Inc. if such a procedure is needed.

Caution: ***Do not use solvents to clean the Aeroquip fittings. The fittings come pre-lubricated from the factory and should never be greased or oiled. Otherwise the helium circuit could become contaminated.***

7.6 Returning Equipment

Before returning any equipment, contact Oxford Instruments Austin, Inc. to receive special instructions and to obtain a return authorization (RMA) number. See contact information in Chapter 1, Section 1.2.

Figure 4-2 **Model 600 / Model 400 Helium Compressor High Voltage Electrical Schematic**



OXFORD INSTRUMENTS
The Business of Science®

Figure 4-3 Model 600 / Model 400 Helium Compressor Low Voltage Electrical Schematic

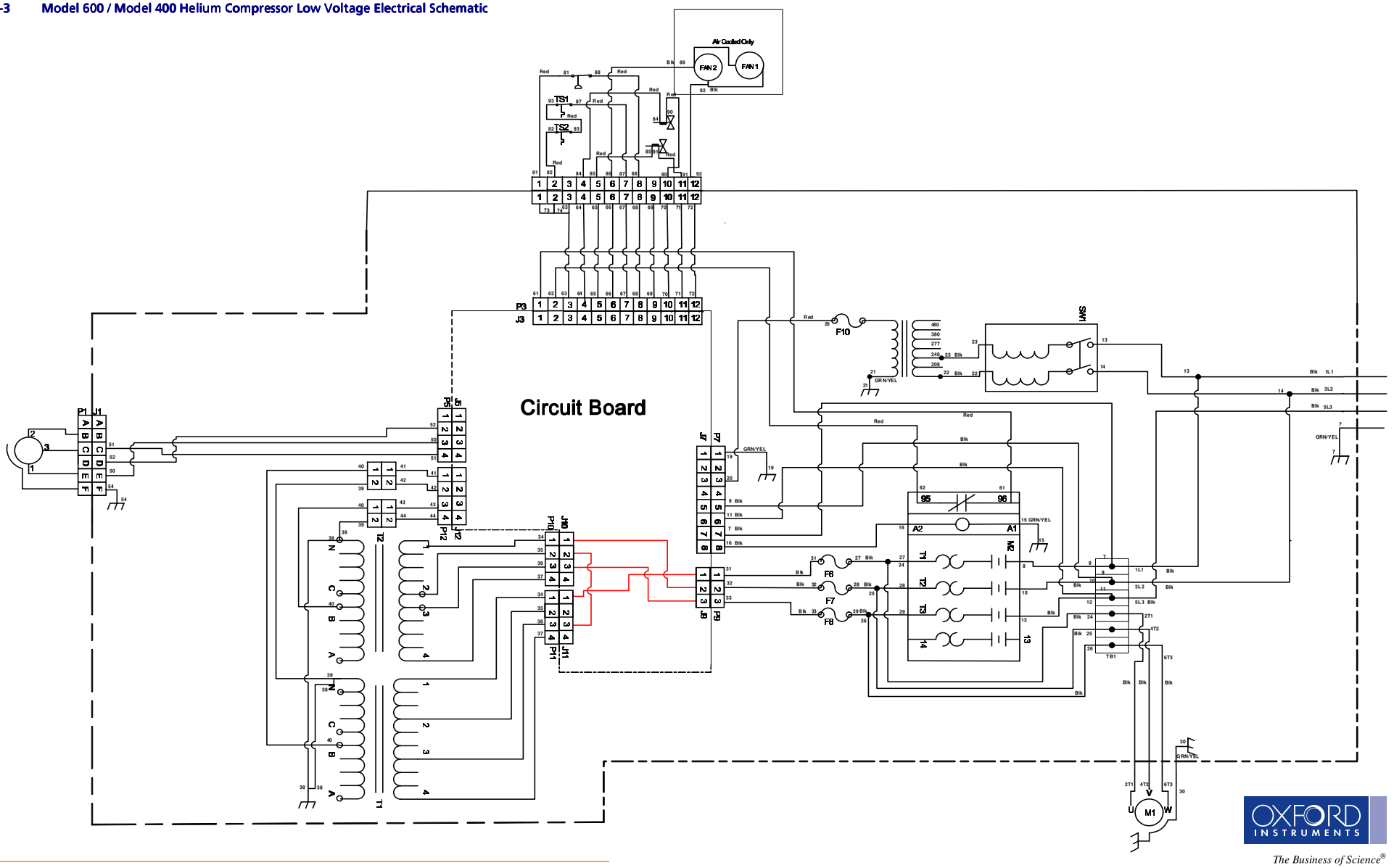


Figure 4-4 Model 600 / Model 400 Helium Compressor Low Voltage Onboard Electrical Schemtic

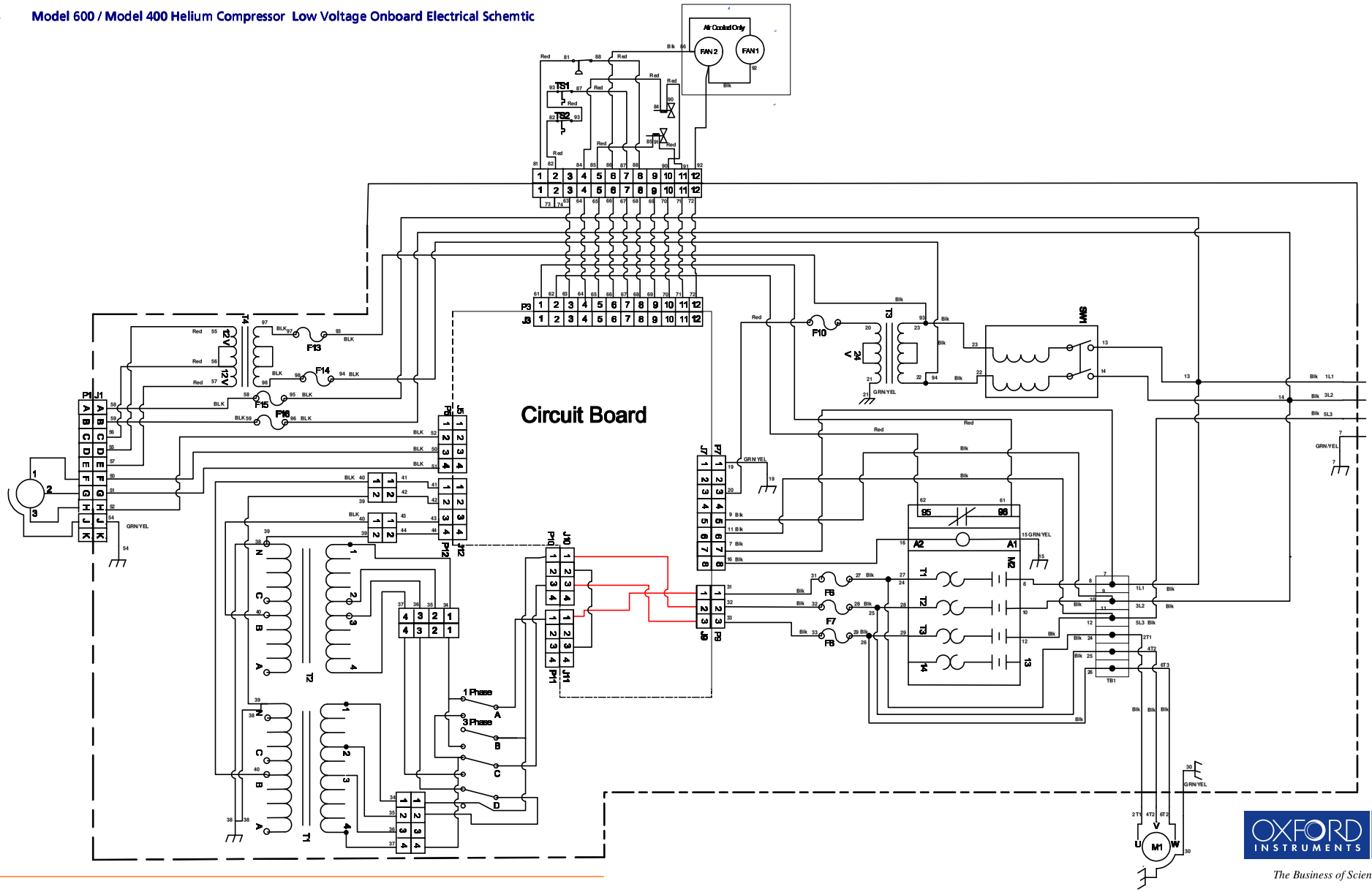


Figure 4-5 Model 600 / Model 400 Helium Compressor High Voltage MRI Electrical Schematic