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Appendix A - *RheoVac* Model 950 User Interface Software

Appendix B - *RheoVac* Model 950 Networking

Appendix C – New Features and Options for the *RheoVac* Model 950

## WARRANTY

Intek, Inc. warrants each *RheoVac* product to be free from defects in material and workmanship under normal use and service, Intek's obligation under this warranty being limited to making good any part or parts thereof which shall, within one (1) year after delivery of such product to the original purchaser, be returned to Intek with transportation charges prepaid and which Intek's examination shall disclose to its satisfaction to have been thus defective; this warranty being expressly in lieu of all other warranties, express or implied and all other obligation or liabilities on Intek's part. The purchaser will assume all responsibility and expense for removal, decontamination and reinstallation of equipment.

*RheoVac* instruments are manufactured under United States patent numbers 4,255,968, 5,485,754, 5,752,411 and 6,526,755. Intek, *Rheotherm* and *RheoVac* are registered trademarks of Intek, Inc.

*Windows is a registered trademark of Microsoft Corporation in the United States and other countries.*

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## SECTION 1 — GENERAL INFORMATION

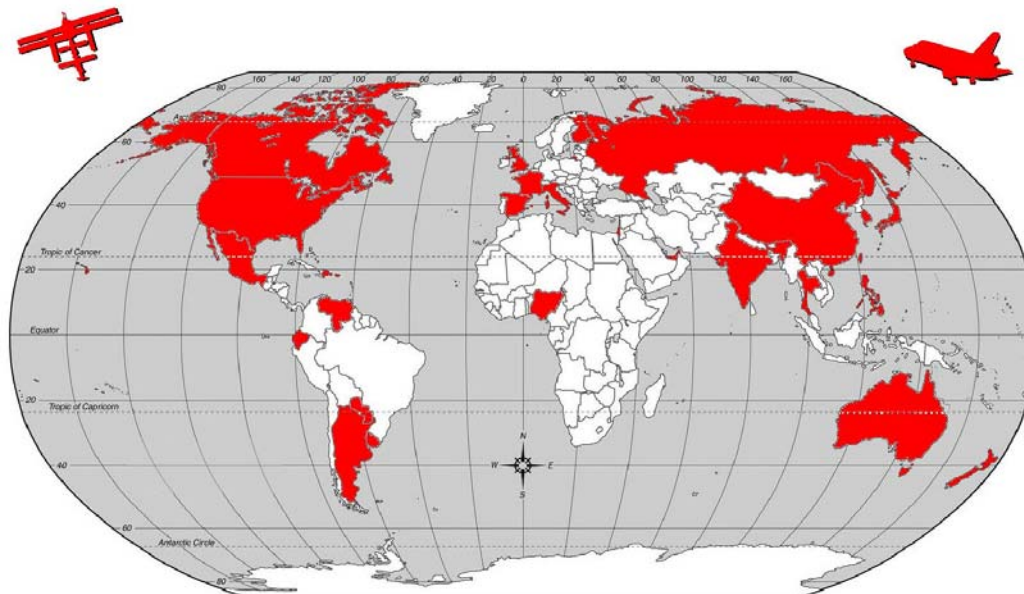
### 1.1 INTEK'S POWER INDUSTRY SERVICES

Intek manufactures *RheoVac* condenser and air in-leak monitor *Rheotherm* circulating water flow and fouling meters, flow meters, flow switches, as well as, temperature sensors and pressure probes. These specialty instruments for the power industry provide continuous monitoring of critical parameters that have historically been unavailable or inadequately measured since steam surface condensers were introduced.

The data from these instruments have been used to gain a unique comprehensive understanding of steam surface condensers and the condensation process. This understanding has enabled us to help customers troubleshoot condensers with greater speed and accuracy than ever before. We have expanded our service offerings by developing an online diagnostic toolkit for steam surface condensers, available at [www.MyCondenser.com](http://www.MyCondenser.com).

We have also taken advantage of our aerospace design tools and design expertise for the purpose of designing condenser retrofits for performance and condensate chemistry improvement. Intek has lead condenser retrofitting projects that have transformed underperforming condensers into some of the best performing condensers in the world.

The condenser services team under Dr. Joseph Harpster's leadership has also sought to educate the industry by contributing volumes of material to ASME and EPRI regarding proper condenser measurement and steam flow dynamics. Intek also teaches a semiannual Condenser Operations and Management Workshop accredited by The Ohio State University for Continuing Education Credit. Tutorials and case studies are also available at [www.MyCondenser.com](http://www.MyCondenser.com).



***Intek is The Gateway to Improved Condenser Performance, Fast Response Maintenance and Optimized Operations. Thank you for your interest in Intek's Power Industry Instruments and Services.***

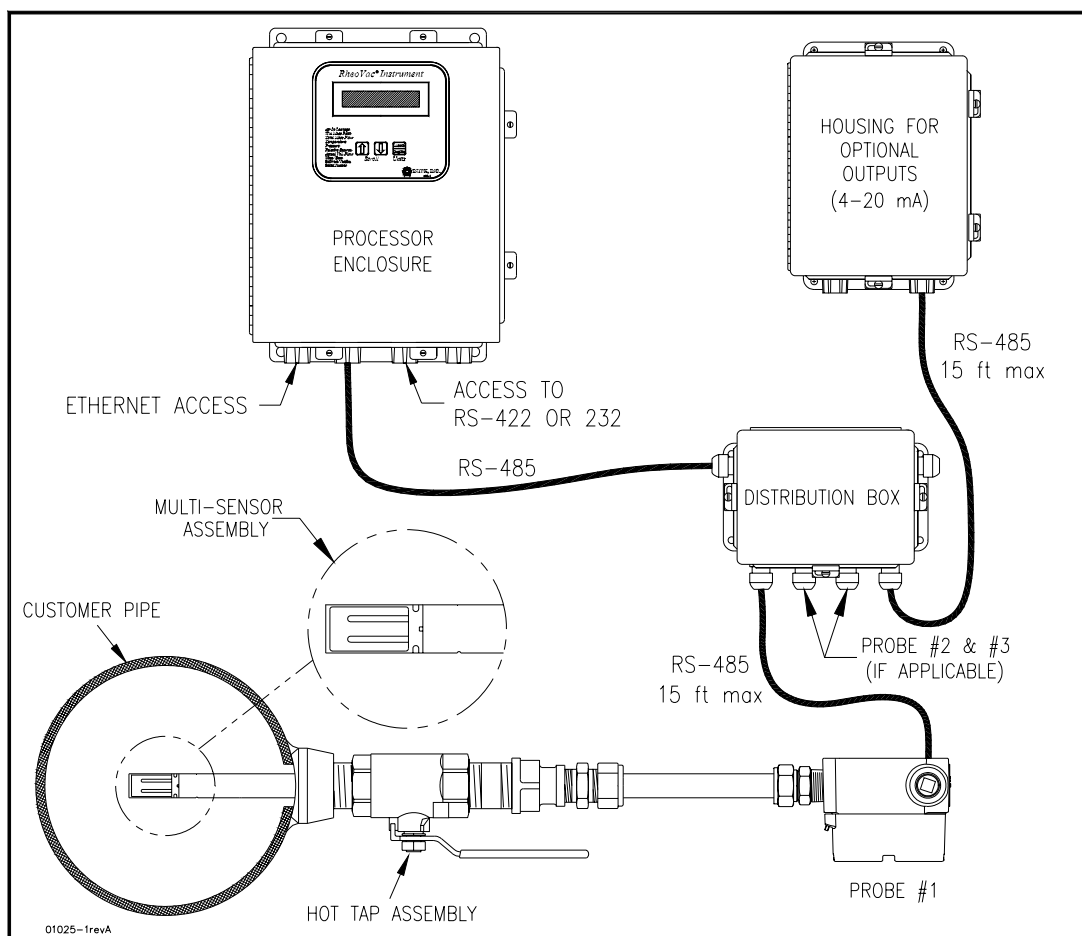
## 1.2 INTRODUCTION

*RheoVac* technology provides direct measurement of all necessary properties of the gases, in the condenser exhaust line, to give an accurate determination of air in-leakage and condenser performance related parameters. The *RheoVac* instrument is a part of Intek's services that provide the power industry with the most advantageous and complete measurement and diagnostic tools for condenser systems. Other measurement instruments offered by Intek include circulating water flow and fouling meters, flow meters, flow switches, condenser shell pressure and temperature sensors.

### the *RheoVac*® System\*

\*USPNs 4,255,648; 5,485,754; 5,752,411; 6,526,755

A model 950 *RheoVac* system consists of single or multiple probes reporting to a central signal conditioner and processor unit. The sensing probes, consisting of multiple sensors, are installed in the vacuum line between the condenser and the exhauster. The sensor assembly employs the patented *Rheotherm*® technology to provide an accurate mass flow measurement. Additionally, temperature, pressure and water vapor relative saturation measurements are made using high accuracy platinum resistance temperature detectors (RTD), strain gauge pressure sensor and specially configured and calibrated water vapor saturation sensor.



**Figure 1** *RheoVac* Model 950

### 1.3 PRINCIPLE OF OPERATION

The *Rheotherm* flow sensor is calibrated to measure the total mass flow of the gaseous water vapor/air mixture. From the other three measurements, the *RheoVac* electronics converts the total gas mass flow signal from the probe into two components, air mass flow rate and water vapor mass flow rate.

The *RheoVac* system is fully calibrated at the factory under dynamic fluid conditions identical to those within the power plant vacuum line. Field adjustments are not required, with the exception of line size.

### 1.4 TECHNICAL SPECIFICATIONS

#### 1.4.1 Sensor (Probe) Specifications

Primary Calibration Accuracy:

±5% of total mass flow

Repeatability:

±0.5% of reading

Operating Temperature:

Electronics: 40 to 120°F (5 to 49°C)

Probe: 40 to 160°F (5 to 71°C)

**Never subject probe to temperatures above 210°F (99°C)**

Operating Pressure:

0.5 to 10 inches Hg absolute

15 psi maximum

Storage Temperature:

-20 to 210°F (-29 to 99°C)

Storage Pressure:

15 psig (maximum)

Process Connection:

Hot tap assembly

(1½" thread-o-let must be welded to pipe for hot tap installation)

Wetted Surface:

300 Series SS and engineered plastic

#### 1.4.2 Main Electronics (Remote or PC) Signal & Data Access

Local Display:

Back-lit LCD

Selectable display of air in-leakage and 6 additional instrument output parameters

Parameter scrolling

Metric/English units

Input Power:

100-250 Vac, 50/60 Hz

Signal Output or Data Access:

RS-232/RS-422/Serial Modbus, Ethernet, TCP/IP

Eight 4-20mA signals (optional)

Wireless (Optional)

OPC (Optional)

Temperature Environment:

Operating: 40 to 120°F (5 to 49°C)

Storage: -20 to 210°F (-29 to 99°C)

## 1.5 PRECAUTIONS AND RECOMMENDATIONS

- Read the entire manual before installing and operating the *RheoVac* system.
- **WARNING — Be sure to power up your *RheoVac* instrument system and probe(s) for at least 30 minutes before inserting probes into the vent line hot taps. DO NOT leave probe in vent line without power or when flooding the condenser.**
- Carefully select the best locations for installation of the probes. Access, orientation, installation clearances, freedom from standing water, absence of water traps, minimum required straight-run should all be considered when selecting a probe location.
- Use reasonable care in handling the probe — the sensing components are delicate. Do not bend the probes, damage the tips, or obstruct the sensing ports. If shipping the unit, make sure the probe is adequately protected from foreign objects and damage; save and reuse factory provided custom probe protector and shipping boxes.
- Use proper input power — it must be between 100 and 250 Vac (nominal 120/240 Vac) at 50/60 Hz (60 Hz nominal).
- Confirm the line and environmental temperature is always within the probe and electronics ratings — never operate a probe at or subject it to temperatures or pressures beyond its specified limits. (See SECTION 1.4)
- **WARNING — Never allow live high temperature steam to flow either direction in the exhauster line where a probe is located. This can happen if steam jet ejectors are operated incorrectly.**
- **WARNING — Do not allow the instrument sensors (or separate RS probe) to come into contact with liquid water, including water from condenser flooding (hydro testing) and entrained liquid water — entrained liquid water is an indicator of poor condenser venting and may be present in your condenser vent line due to design configuration. See EPRI's "Air In-Leakage and Intrusion Prevention Guideline," TR 1014125. Intek provides analysis and design services to improve condenser venting and reduce or eliminate entrained liquid water and excess condenser back pressure.**
- Keep moisture out of the enclosures — once all service connections are made, make sure all gaskets are in place and the enclosure lids are tightly closed. Seal all conduit lines.
- Intek recommends using the RJ-45 network connection for all data traffic (as opposed to serial and 4-20 mA communication).
- Intek recommends a service contract to ensure probes are within calibration specifications and electronics are maintained with appropriate software/hardware updates. Instrument probes should be returned to the factory for inspection and calibration service every two years.
- Intek recommends the use of condenser diagnostic tools and tutorials provided on [www.MyCondenser.com](http://www.MyCondenser.com).

## SECTION 2 — INSTALLATION

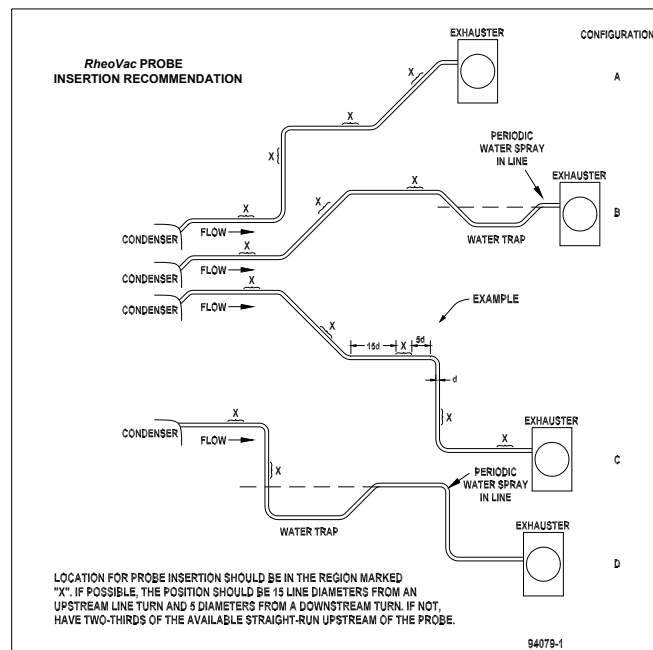
These instructions are general guidelines for the installation of *RheoVac* instruments in their standard configuration. Additional information pertaining to your unit is covered in SECTION 6 — CUSTOM INFORMATION. Carefully read these instructions prior to installing the equipment. Also, see preceding SECTION 1.5; PRECAUTIONS AND RECOMMENDATIONS.

### 2.1 *RheoVac* SYSTEM INSTALLATION/SITE SELECTION

The standard *RheoVac* 950 can be configured with one, two or three probes. A three probe system is intended to be installed so that one probe is in each of the two exhaust lines coming out of the condenser (A side and B side). The third probe should go in the header pipe that runs to the exhauster(s). Other installation arrangements of multiple probes should be discussed with the factory. High temperature dual probe systems (where each “probe” is comprised of a matched main FTP probe and an RS probe pair) have different configuration limitations for a given *RheoVac* 950 system.

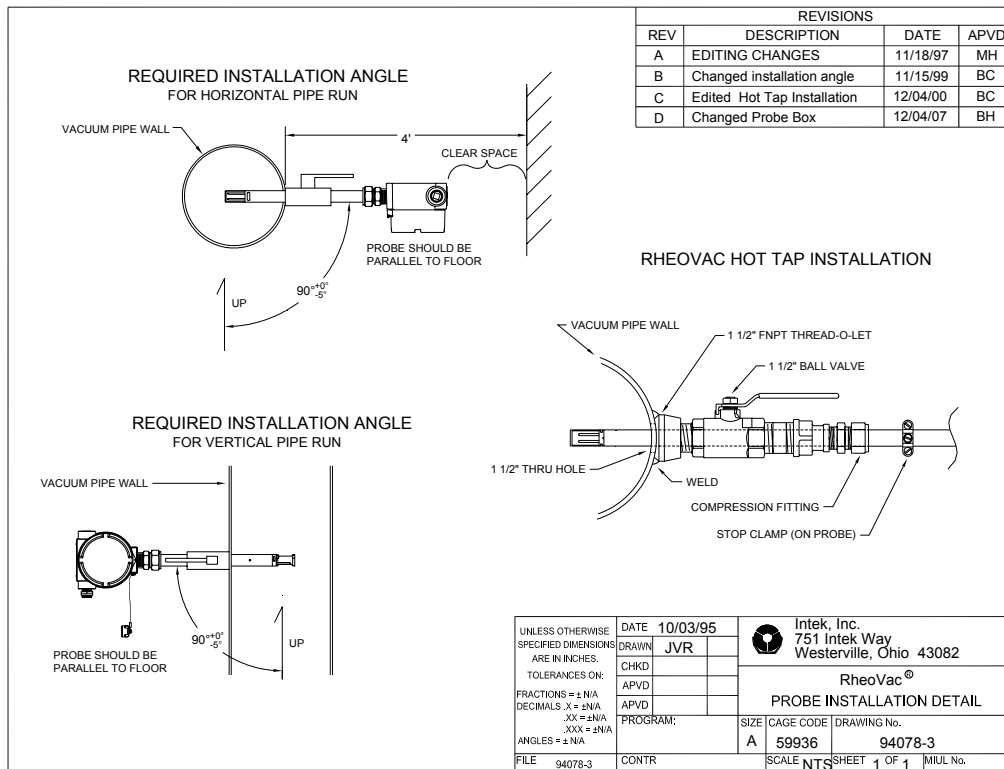
#### 2.1.1 Probe Site Selection

- The location for each probe should be selected so as to provide the probe sensing area with well-established mean flow velocity, uniform system temperature and pressure, and consistent non-liquid phase flow medium. Pipe sections ahead of a probe, in which water can accumulate, must be avoided. Refer to Figure 2 and select the most preferred location for each probe. Do not install the probes beyond any “trap” sections as shown in Figure 2, Configurations B and D. Special installation instructions unique to your unit, where applicable, will be noted in SECTION 6.3 SPECIAL INSTRUCTIONS. Refer to this section now to review special instructions.



**Figure 2** *RheoVac* Probe Insertion Recommendation

- Check installation clearance. Each transducer probe is approximately 3 feet (0.9m) long and the hot tap assembly is approximately 13 inches (0.33m) long, therefore, allow minimum clearance of 4 feet (1.3m) for probe insertion. Be sure there are no obstructions around the vacuum line that will interfere with probe insertion. Figure 3 shows the proper insertion angle. THIS ORIENTATION IS IMPORTANT FOR PROPER OPERATION.



**Figure 3** Transducer Installation Detail

- It is recommended that only Intek supplied hot taps be used. The hot tap length affects the insertion depth of the probe and must be accounted for; likewise, the proper port clearance for the probe's maximum diameter.
- Observe the selected sites; check for ease of access. They should be convenient for the removal and replacement of probes at any time for service without ladders, building scaffolding or waiting for plant shutdown.
- Check operating conditions. The temperature and pressure limits (see TECHNICAL SPECIFICATIONS; SECTION 1.4) of the unit should be checked to ensure compatibility with your application.
- Gases in the air removal line should be free of liquid water, mist or fog. Wetness in the line will result in erroneous readings from the instrument and can damage sensors. If wet conditions exist in the air removal line, there is either air removal section damage or design flaws which adversely affect condenser performance. Consult Intek for assistance in evaluating the severity of the problem and possible remedies.



### 2.1.2 Electronics Unit Site Selection

The Model 950 typically has two or three electronics enclosures (see Figure 1). The processor enclosure and other electronics boxes should be installed in a convenient location and should be kept away from direct sources of heat, such as non-insulated steam lines, or moisture. The maximum temperature rating of electronics is 120°F; ensure that this temperature will not be exceeded inside the enclosure. Once the wiring connections are made, close and latch down the box lid to protect the contents from damage and debris. All these enclosures should be located in a dry area and should be kept clamped shut during normal operation. Do not allow water to get into the enclosures. If installed outdoors, build a roof over all enclosures to prevent potential water infiltration.

- Processor Enclosure: This 12x10 NEMA 4 enclosure houses the display and central processing unit. Input power (100-250 Vac, 50/60 Hz) is connected inside this enclosure.
- Distribution Box: This 8x6 NEMA 4 enclosure is typically located near the probe that is closest to the processor enclosure unit. It is connected to the main processor with an RS-485 bus DeviceNet™ cable, which can be hundreds of feet long. The probe and transmitter RS-485 cable connections are also made within this box. **The probe and transmitter cable lengths should be 15 ft or less.**
- Transmitter Box (optional): This 10x8 NEMA 4 enclosure contains terminals for accessing the eight 4-20mA signals. It can be located in or near the control room so that the 4-20 wires do not have to be run from the plant floor. An RS-485 DeviceNet™ cable runs from the distribution box to the transmitter box. (There are restrictions on how this can be done, so check manual SECTION 6, or contact the factory.)

## 2.2 PROBE INSTALLATION

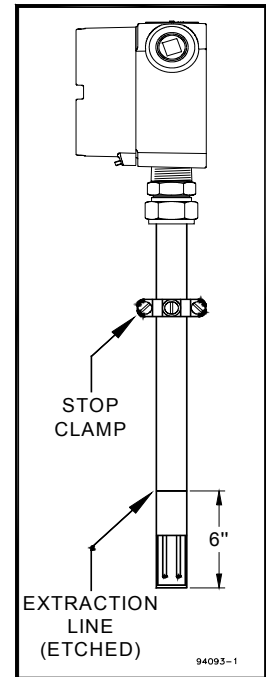
### A. Hot Tap Installation

1. Check hardware. Verify that the probe slides easily through the hot tap assembly and pipe penetration hole.
2. Verify there is a minimum probe insertion clearance of 4 feet (1.3m) between pipe surface and any obstruction.
3. Install the mounting hardware. Drill a 1½" through-hole, center the thread-o-let over the hole and weld it onto the condenser vacuum pipe (see Figure 3). Thread the hot tap assembly into the thread-o-let. Use thread tape or pipe dope to seal the connection. (Alternate: weld thread-o-let to pipe wall, then drill a 1¼" hole in pipe wall using a hot tap drill.)
4. Make sure the probe is parallel to the floor (see Figure 3). Be sure location is accessible for probe removal and maintenance.

### B. Installing/Removing the Probe

1. It may be necessary to apply a force of about 23 lb (102 Newtons) to remove or replace the probe under plant operating conditions.
2. Check proper installation direction. Each probe has a directional arrow on the junction box. Before installing the unit, note proper flow direction. This is important to instrument operation.

3. Check serial number (S/N). If more than one *RheoVac* system has been purchased, make sure the first five digits of the serial numbers of the probe(s) match the first five digits of the serial number of the main processor unit. The electronics and up to three probes are a matched set. Mismatched components will not work correctly. The dash number on the probe S/N is the probe number shown on the display. Record the probe number and installation location for future reference.
4. Verify stop clamp location (see Figure 4). A stop clamp is attached to each probe as an indication of its insertion depth. It is important that the stop clamp is securely in place to position the sensors in the correct location and to ensure that the probes do not contact the opposite pipe wall. Contact with the pipe wall could damage the probe. The clamp's location is determined based on your submitted pipe diameter, as shown in SECTION 6.2, and is marked with a groove on each probe shaft. Refer to this mark if a stop clamp is inadvertently moved. When installed in the line, the two metal probe tips should be in the middle of the pipe.
5. Prior to inserting probe, loosen the compression nut on the thermocouple connector of the hot tap and clean the inner surface of the thermocouple connector to ensure it is free of particles that may cause probe damage.
6. Be sure to power up your *RheoVac* instrument system and probe(s) for at least 30 minutes before inserting probes into the vent line hot taps. DO NOT leave probe in vent line without power or when flooding the condenser.
7. Install each probe. The probe should be mounted through the pipe wall using the hot tap assembly. The probe installs so that the two sensor tips are side-by-side across the gas stream. Each probe has a flow directional arrow on the junction box. Make sure the probe orientation is correct. When installing under vacuum, do not allow the clamp to "slam" against the seal nut upon opening the valve. Grasp the probe firmly, with hand against the seal nut, before opening the ball valve. Allow the probe shaft to slide slowly through the valve by controlling the amount of grip on the probe shaft. Special installation instructions, if any, will be noted in SECTION 6.
8. When removing the probe from the vent line, loosen the compression on the thermocouple connector of the hot tap and slowly pull the probe out of the line until the extraction line is visible (see Figure 4). Close the ball valve and remove the probe from the hot tap.



**Figure 4** Probe  
Stop Clamp

## 2.3 ELECTRICAL CONNECTIONS

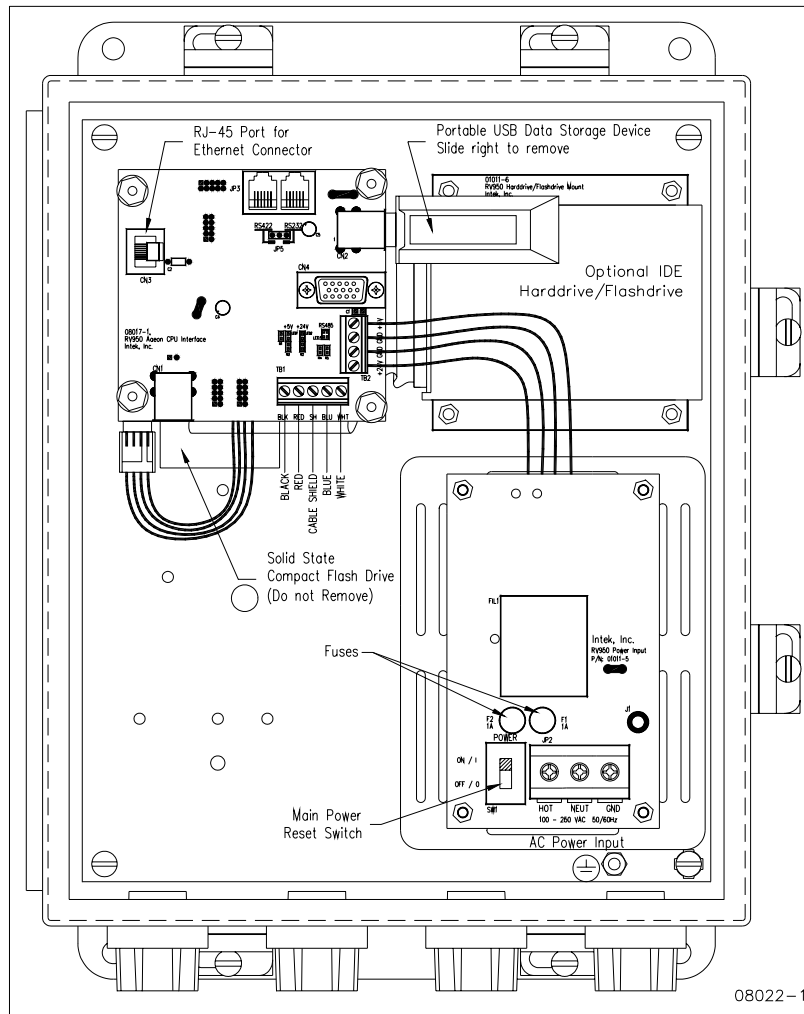
**IMPORTANT** — Inspect and **VERIFY** these electrical connections carefully. Improper connection could damage electronic components and sensor function. If additional holes need to be drilled in the processor enclosure, remove the electronics subassembly (mounted on a mounting plate) and temporarily store inside an ESD bag in a safe, clean place. Do not drill with electronics boards inside the enclosure.

A. Main Processor Unit (see Figure 5)

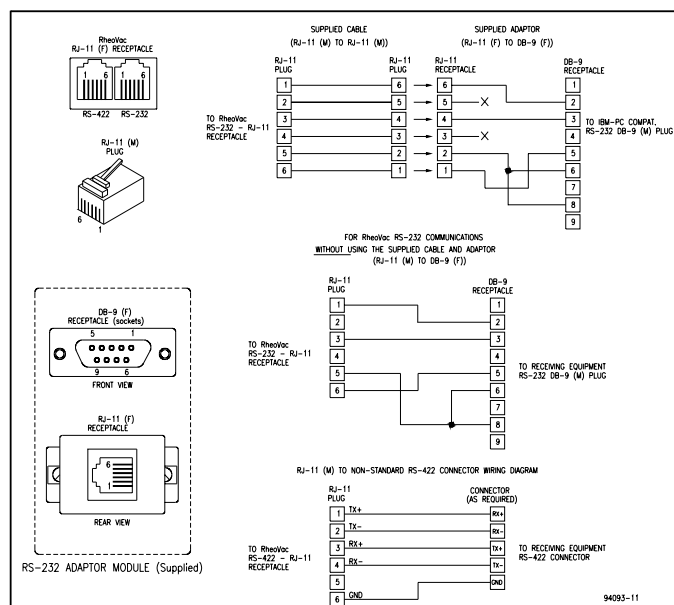
1. Sensor Power and Communication Line: Connect the distribution box to this main processor box using the RS-485 communications/power cable. Follow indicated connector color code. [communications: white (A), blue (B) and shield (SH); power: 24Vdc, red (+), and black (-)]
2. Main Power: Connect main power terminals to a dedicated 100-250Vac, single phase, 15-amp circuit. An external disconnect switch should be used for disconnecting power to the system during outages. Power connection wires should be at least 18 gauge and comply with accepted wiring codes. SW1 on the power input PWA (printed wiring board #01011-5) is used for cycling power to reset.
3. Network Connection (Recommended): The Ethernet connection at CN3 on the CPU interface PWA (printed wiring board #08017-1) is an RJ-45 style jack. A 10-foot Ethernet Cat5 crossover cable is supplied with the unit for laptop connections. Intek recommends using this connection for all data transmissions and *RheoVac* communications because:
  - a. More measured data is accessible through the network connection.
  - b. Software and calibration file updates can be done remotely.
  - c. Archived data files can be easily retrieved and analyzed by Intek through online software available at [www.MyCondenser.com](http://www.MyCondenser.com).
4. Serial Communication: Connector JP3 on the CPU interface PWA (printed wiring board #08017-1) is the RS-232 serial communication interface. This interface should only be used for distances of 20 feet or less, such as to a laptop computer. A 20-foot serial cable with a DB-9 connector is available from Intek upon request (see Figure 6 and Table 1). An RS-422 serial communication interface is present for long data communications when configured without 4-20 mA outputs. *Note: Intek recommends using the network connection for all data transmissions and RheoVac communications.*

**Table 1** RJ-11 to DB-9 Module Adapter

RS-232 CONFIGURATION				RS-422 CONFIGURATION			
RJ-11 Pin Out		DB-9 Pin Out		RJ-11 Pin Out		DB-9 Pin Out	
1	Tx (transmit)	1	N/C	1	Tx+ (transmit+)	1	Rx- (receive-)
2	N/C	2	Tx (transmit)	2	Tx- (transmit-)	2	Rx+ (receive+)
3	Rx (receive)	3	Rx (receive)	3	Rx+ (receive+)	3	Tx+ (transmit+)
4	N/C	4	N/C	4	Rx- (receive-)	4	N/C
5	Power (+5V)	5	Ground	5	Power (+5V)	5	Ground
6	Ground	6	Pulled high	6	Ground	6	Tx- (transmit-)
		7	N/C	7		7	TBD
		8	Pulled high	8		8	TBD
		9	N/C	9		9	TBD



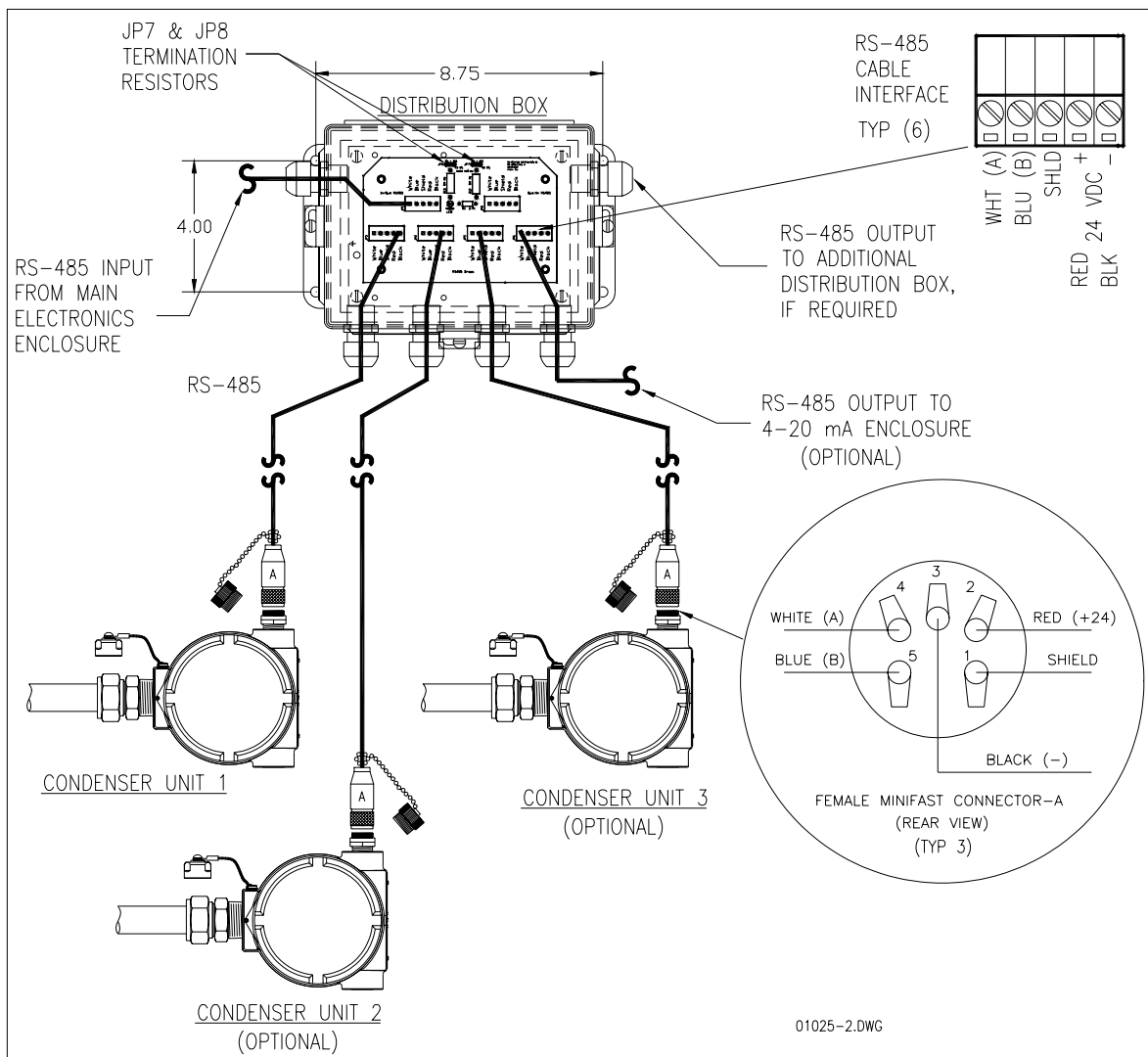
**Figure 5** Output Connections and Set-up



**Figure 6** Serial Communication Interface

## B. Distribution Box (see Figure 7)

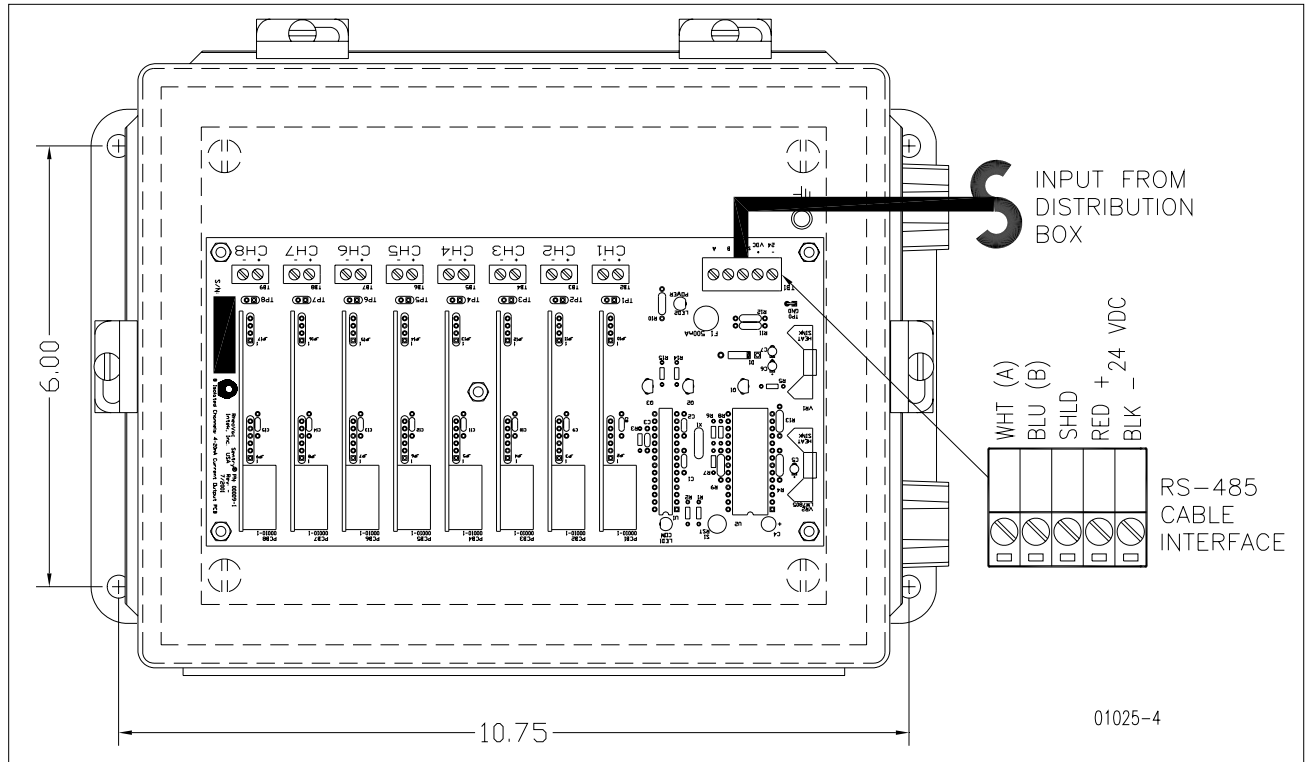
1. Connect the RS-485 wires (blue, white and shield) and 24Vdc power (red and black) from the main processor unit to screw terminal, JP1.
2. Install ½" liquid-tight conduit between the distribution enclosure and the probes unless ½" rigid conduit is used for long distance runs. Use a minimum of 6 feet of liquid-tight conduit at the probes.
3. The probe connector comes with an adapter which allows the attachment of the ½" flexible conduit connector.
4. Connect the probes to the distribution enclosure using the manufacturer supplied four conductor shielded cable to any screw terminals labeled JP3 to JP6. Probe cable connections are shown in Figure 7.
5. For multiple distribution box configurations, screw terminal JP2 will be used to wire the manufacturer supplied four conductor shielded cable to screw terminal JP1 on the next distribution box in series.
6. Optional — Connect the transmitter box to the distribution box using a RS-485 cable.
7. If no additional distribution boxes are used, ensure the outgoing termination resistor (JP7 or JP8) is enabled.



**Figure 7 Distribution Box**

C. Transmitter Box (optional, see Figure 8) — For driving eight (8) remote 4-20 mA analog signals from one RS-485 input port. *Note: Intek recommends using the network connection for all data transmissions and RheoVac communications.*

1. Connect the RS-485 communications/power cable from the distribution box (RS-485: white and blue wires; 24Vdc power: red and black wires).
2. Connect up to eight (8) signal wire pairs to the indicated terminals for isolated 4-20mA outputs.

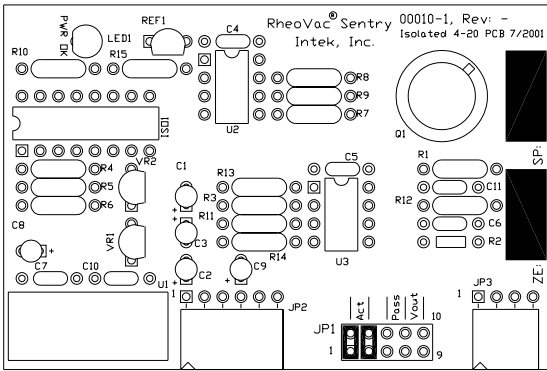


**Figure 8** Optional Transmitter Box

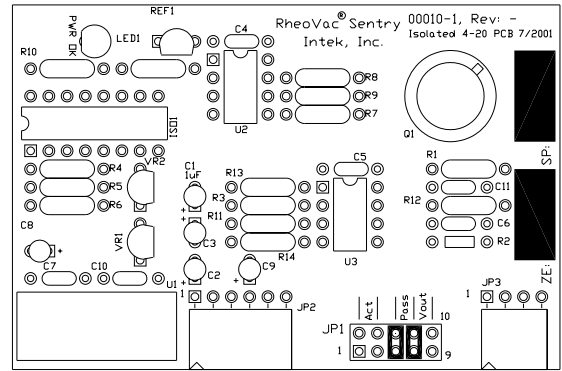
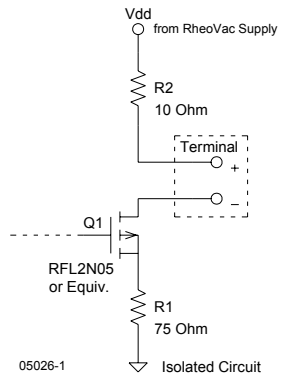
3. Figure 8 provides the *RheoVac* wiring detail for the 8 channel 4-20 mA outputs. Table 2 provides the appropriate connection identification. Model 950 transmitters are configured as active (transmitter sources the current) when shipped. To change to the passive mode (receiver to source the current), extract each small 4-20 board, find the JP1 pins, and move the two jumpers from the “Act” pins to the “Pass” pins (two positions to the right of factory settings). Figure 9 shows the current output circuit. The figure also illustrates the active mode and the passive mode configurations.

**Table 2** Optional 4-20 mA Configuration

Channel	Output Parameter
1	Actual Volume Flow
2	Total Mass Flow
3	Water Vapor Flow
4	Pressure
5	Water Vapor/Air Mass Ratio
6	Relative Saturation
7	Air In-Leak
8	Temperature

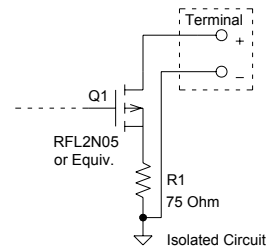


## Active Configuration



## Passive Configuration

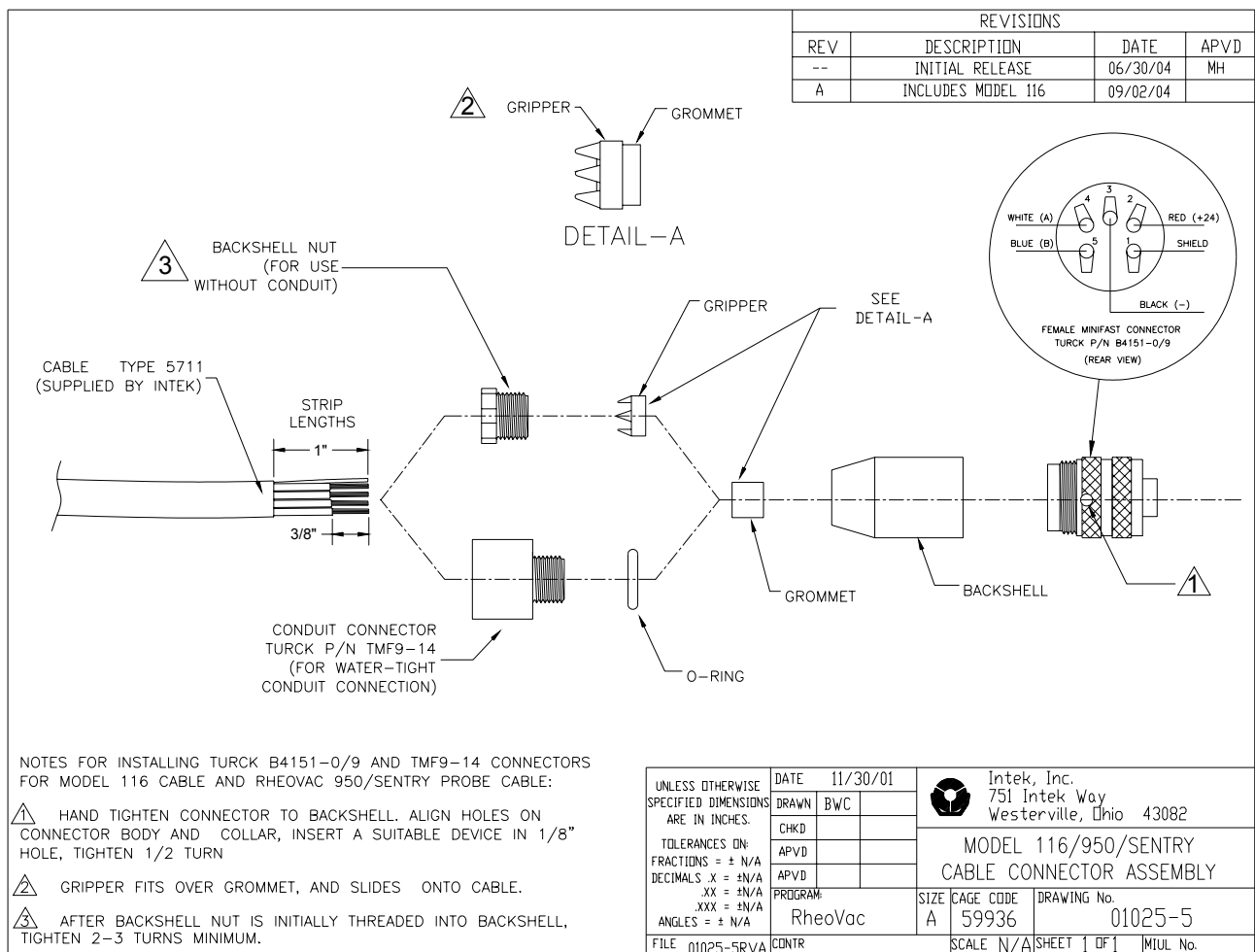
CAUTION: Do not move config. jumpers if instrument is powered.



**Figure 9 4-20 mA Output Circuit**

D. Probe: **CAUTION — Do not cross thread connection.** The probe is supplied with a convenient plug-in connector. The male side of the connector comes installed in the probe junction box. The female side is usually shipped loose and must be installed onto the supplied DeviceNet™ type 5711 cable once it is run from the Distribution Box to the probe. The wiring detail for the female plug-in connector (Turck p/n B4151-0/9) can be seen in Figure 10. These connectors will use either the “backshell nut” or “conduit connector” depending on whether the cable is installed in a liquid-tight conduit. When installing without conduit, use the backshell nut; when using liquid-tight conduit, use the conduit connector with o-ring.

1. Slide all of the appropriate parts onto the cable as shown.
2. Strip the cable conductors as shown. The connector has 5 retention screws to hold the wires in place. The use of crimp pins on the wires will greatly increase connection reliability.
3. Loosen all 5 retention screws (do not completely remove).
4. Insert the wires, in accordance with color-coding shown (see Figure 10, insert).
5. Tighten the retention screws on each wire.
6. Reassemble the connector parts.



**Figure 10** Probe Connector Assembly



## SECTION 3 — OPERATION

The *RheoVac* system is calibrated, compensated, and linearized for a wide range of flowing media temperatures, pressures, and water vapor contents. However, abrupt changes in these parameters can cause the instrument to temporarily read the flow rate improperly, which could lead to transient spikes in the flow indication. In particular, if liquid (water) hits the probe tips, there will be high flow indications until all the water vaporizes. If liquid (water) is present for extended periods, the performance of the instrument will be compromised or the sensors can be damaged.

### 3.1 SYSTEM START-UP

Verify wiring from SECTION 2.3 is correct. With all power off, place the power *OFF/ON* switch, SW1 on printed wiring board #01011-5, to “ON.” Close the main processor enclosure lid. While watching the main processor display, apply power to the instrument. After about twenty seconds the display should initialize to “*Health Check in Progress*” followed by additional initialization status messages. Within two minutes the display should indicate “Air In-Leak.”

Be sure to power up your *RheoVac* instrument system and probe(s) for at least 30 minutes before inserting probes into the vent line hot taps. DO NOT leave probe in vent line without power or when flooding the condenser. (See SECTION 1.5 for precautions and recommendations.)

### 3.2 PORTABLE USB DATA STORAGE/Warranty Registration Instructions

Intek’s warranty program is stated at the front of the manual. To validate warranty:

1. Locate portable USB Data Storage Device in the main electronics enclosure (see Figure 5).
2. Grasp bracket and carefully remove portable USB Data Storage Device.
3. E-mail all *RheoVac* instrument data to [techsupport@intekflow.com](mailto:techsupport@intekflow.com) or upload to [www.MyCondenser.com](http://www.MyCondenser.com).
4. Replace portable USB Data Storage Device in the main electronics enclosure.

**CAUTION** - Do not attempt to use non-Intek approved USB flash drives with the *RheoVac* instrument. Your *RheoVac* instrument may not have the proper drivers installed for other USB flash drives. This may cause the *RheoVac* instrument to lock-up and require service.

### 3.3 DISPLAY

The *RheoVac* 950 has a 2x20 alphanumeric scroll-through display that shows seven parameters for each probe. The display shows Air In-leakage, W/A Mass Ratio, Total Mass Flow, Temperature, Pressure, Relative Saturation, or Actual Volume Flow (as well as Time/Date, Software Version, or Serial Number). To change the displayed parameter, press the *Scroll Up* or *Down* arrows. The display units can be changed from English or Metric units by pressing the *Units* button.

If the Model 950 has two or three probes the display will show two or three serial numbers at a time, one for each probe. The numbers will be in order, from the lowest serial number to the highest, reading from left to right on the display. Example: 02611-1, 02611-2 and 02611-3.

### 3.4 COMMUNICATIONS

Typical *RheoVac* 950 instruments have an Ethernet port, two serial communications choices (RS-232 or RS-422) and optional eight 4-20 mA output signals for each probe. All 4-20 mA output signals are linearly scaled such that 4 mA represents 0% of the rated full scale value (except temperature, which is 0°C) and 20 mA represents 100% of the rated full scale value (temperature is 100°C). The standard full scale values and definitions of all process variables are listed in Table 3. *Note: Intek recommends using the network connection for all data transmissions and RheoVac communications.* Communication with the *RheoVac* unit using Intek supplied software is discussed in Appendix A of this manual.

**Table 3** Process Variable Definitions and 4-20 mA Range\*

PROCESS VARIABLE	4-20 mA FULL SCALE	PROCESS VARIABLE DEFINITION
ACTUAL VOLUME FLOW ACFM [m <sup>3</sup> /hr]	5000 [8,500]	The actual volumetric flow rate of gases leaving the condenser. It is a measure of exhauster capacity. Decreased capacity means pump degradation.
TOTAL MASS FLOW lbs/hr [kg/hr]	10000 [4,536]	The total mass flow rate of the flowing gas. Note: this value is not a measure of air in-leak. It is a measure of total vapor and air removal and exhauster operating capacity.
WATER VAPOR MASS FLOW lbs/hr [kg/hr]	8000 [3,629]	The water vapor component of the flowing gas being removed from the condenser.
<i>RheoVac</i> PRESSURE ” Hg [mm Hg]	30 [762]	Absolute pressure at the <i>RheoVac</i> probe head. Should be equal to or less than turbine back pressure.
WATER to AIR MASS RATIO	20	Ratio of water vapor flow rate to dry air flow rate. Defines “vacuum quality.”
RELATIVE SATURATION [%]	100	The percent concentration of water vapor in the extraction line relative to saturation.
AIR IN-LEAK SCFM [nm <sup>3</sup> /hr]	100 [169.9]	Actual measure of air volume flow rate passing the <i>RheoVac</i> sensor head, normalized to standard conditions (70°F, 29.9” HgA).
<i>RheoVac</i> TEMPERATURE °F [°C]	212 [100]	4 mA = 0°C or 32°F, 20 mA = 100°C or 212°F Temperature of the flow media at the <i>RheoVac</i> probe head.

\*See Custom Information section (Section 6) for custom units of measure.

### 3.5 DATA PROCESSING

A very important part of understanding your condenser system comes from evaluating the data that is measured, created and stored by the *RheoVac* instrument. A data file is created for each calendar day that the monitor is operating. The ability to review stored data has been invaluable when troubleshooting condenser problems. The column heading for each archived data file is seen in Table 4. Intek provides solutions for viewing and analyzing data.

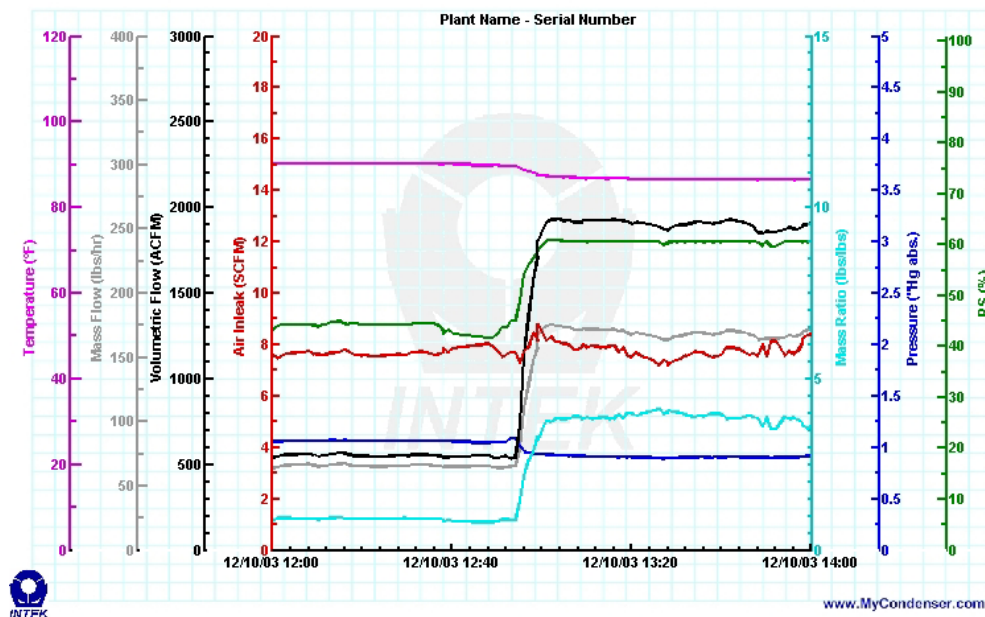
**Table 4** Column Headings for Data Downloads and Archived Data\*

Time Stamp	Actual Vol. Flow (ACFM)	Total Mass Flow (lbs/hr)	Water Vapor Mass Flow (lbs/hr)	<i>RheoVac</i> Pressure (”HgA)	Water Vapor Sp. Vol. (ft <sup>3</sup> /lb)	Water to Air Mass Ratio (lb/lb)	Relative Saturation (%)	H <sub>2</sub> O Partial Pressure (”HgA)	Air Flow In-Leak (SCFM)	Probe Temp. (°F)	RS Temp. (°F)	Raw Total Mass Flow (lbs/hr)	ΔT (°F)	RS Out.
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\*See Custom Information section (Section 6) for custom units of measure.

- A. Using [www.MyCondenser.com](http://www.MyCondenser.com) for plotting (Plotting tools are available free on our website for analyzing *RheoVac* Model 950 data). Must first register as user.
1. Open the website, [www.MyCondenser.com](http://www.MyCondenser.com).
  2. If you are not registered, click the 'register' link at the bottom of the page and follow the on-screen instructions.
  3. Log in to the website using the username and password created during the registration process.
  4. Click on the 'RheoVac' pull down menu at the top of the page and select 'RheoPlotter' from the pull down menu.
  5. Click on the 'Help' link to learn how to upload files, create plots, and change axis limits.
  6. Plots, data, and questions can be submitted to Intek for evaluation through the 'Submit Data and Question to Intek' link at the bottom of the page.
  7. Submitted questions and responses are posted on the user's individual private forum.

Figure 11 is an example plot.



**Figure 11** *RheoVac* data plotted – an illustration

- B. Other features available on [www.MyCondenser.com](http://www.MyCondenser.com)
1. Web Tutorials  
Tutorials can be found in the help menu. This section includes presentations on condenser theory, instrumentation, case studies, and condenser services provided by Intek.
  2. Case Studies  
Posted presentations show events and conditions captured by the *RheoVac* condenser monitor and how the instrument helped to troubleshoot or solve upset conditions. Case studies include information on pump issues, air in-leakage events, steam jet air ejector problems, and general condenser performance troubleshooting, etc. Case studies captured by the *Rheotherm* Circulating Water Flow and Fouling Meter are also presented and discussed. Illustrations on macrofouling, thermal stratification, circulating water pump degradation, and identification of condenser design deficiencies are highlighted.

3. Public Forum

Registration is not required for viewing access to the public forum. This forum is a way to freely exchange ideas and post questions (with registration) to professionals within the power industry.

4. Private Forum

Through the private forum, the registrant will be able to communicate directly with Intek engineers regarding data analysis, condenser services, instrumentation, and other questions. Posts on this forum will only be visible by the user and Intek engineers.

5. Continuous Condenser Monitoring and Performance Analysis

Intek offers services where Intek will continually monitor the user's condenser(s) and provide feedback, action items, and selected performance reports. More information regarding Intek's condenser services is available upon request.

### 3.6 CUSTOM SOFTWARE

Custom software may be developed by the user to receive and archive *RheoVac* data into a computer system. The electronics has a serial data protocol of 9600 baud, no parity check, eight data bits and one stop bit (i.e., 9600,N,8,1). Each transmitted group of data is sent in a standard ASCII coded format representing each process variable value, instrument identification and status information.

The data stream consists of 13 fields, followed by a carriage return <RETURN>. The first ten fields, nine bytes each, are the process variables. Following the process variables are the *RheoVac* serial number, nine bytes; the process identification tag number, 15 bytes; and the *RheoVac* system status, seven bytes. The data stream is then ended by a single <RETURN> byte (ASCII code 13). The total number of bytes transmitted in each data stream is 122 bytes per probe including the trailing <RETURN>. This data group is sent approximately once every three seconds. Table V shows the field names and number of bytes in one data stream.

**Table 5 Serial Output Data Stream\***

Actual Volume Flow (ACFM)	Total Mass Flow (lbs/hr)	Water Vapor Flow (lbs/hr)	<i>RheoVac</i> Pressure ("Hg abs)	Water Vapor Sp. Vol. (ft <sup>3</sup> /lb)	Water to Air Mass Ratio (lb/lb)	Relative Saturation (%)	H <sub>2</sub> O Partial Pressure ("Hg abs)	Air Flow In-Leak (SCFM)	Probe Temp. (°F)	Instr. Serial Number	ID Tag No.	Status	Term. <CR>
9 bytes	9 bytes	9 bytes	9 bytes	9 bytes	9 bytes	9 bytes	9 bytes	9 bytes	9 bytes	9 bytes	15 bytes	7 bytes	1 byte

\* See Custom Information section (Section 6) for custom units of measure.

Each of the first ten process values are sent in the fixed decimal format of XXXX.XXXX with leading and trailing zeros inserted to maintain the nine character length. The next three fields are ASCII text strings followed by the <RETURN>. Example: The nine bytes for an air in-leak of 10.0 SCFM would be: 0010.0000, or 48,48,49,48,46,48,48,48,48 ASCII.

## SECTION 4 — MAINTENANCE

### 4.1 CALIBRATION

The *RheoVac* instrument is calibrated at the factory in a calibration system which replicates the condenser and vacuum line environment. The system is designed to simulate the temperature, pressure, water vapor relative saturation, and flow rate under the gaseous fluid conditions found within the power plant vacuum line.

In general, calibrations should be valid over a two-year period if the probe is well maintained. Should the unit require re-ranging or recalibration, note the serial number of the *RheoVac* instrument and contact the factory concerning recalibration cost and turn around times. Refer to SECTION 5 — CUSTOMER SERVICE of this manual for additional information.

Contact Intek for calibration, condenser monitoring service plans, instrument service agreements as well as other Intek products and services for the condenser and the power industry.

### 4.2 SPARE PARTS

It is advantageous to have a spare probe. Should a spare probe be desired, it can be ordered and stored for installation at any time. A spare probe will come with a parameter disk with calibration files that will need to be uploaded to the main electronics along with instructions to complete the update and install/replace the probe (see SECTION 4.4).

Spare fuses should be available for replacement of blown fuses. Appropriate fuses to stock are:

- 500 mA fuse, slow blow, Wickmann part number 3720500041 or equivalent, for probes.
- 1 A fuse, slow blow, Wickmann part number 3721100041 or equivalent, for the main electronics.

There are no other normally recommended spare components to stock.

To replace the fuse in the main electronics: locate the AC Power Input board (#01011-5 shown in Figure 5) in the lower right hand corner of the main electronics box. Slide the power switch to the “OFF” position to disable power to the electronics. The fuses are shown at locations F1 and F2 (spare). Gently pull the fuse(s) from their sockets and gently insert the replacement 1 Amp fuse(s) as appropriate. Slide the power switch back to the “ON” position to enable power to the electronics. Close hinged lid and verify display backlight is on. Clamp close the enclosure lid, and tighten the latch screws.

## 4.3 TROUBLESHOOTING

### 4.3.1 Diagnostic Messages

Table 6 provides a guide for plant personnel to identify causes of problems and determine appropriate actions to resolve problems observed. If problems are encountered and factory assistance is desired, please contact the factory.

**Table 6** Troubleshooting Guide (Diagnostic Messages)

MESSAGE CODE <i>Description/Symptom</i>	PROBABLE CAUSE	ACTION
MSG-0 <i>Communications not being received from probe(s)</i>	1. Improper cable hookup 2. Blown main fuse 3. Failed RS-485 circuit 4. Damaged flow sensor	1. Verify plug-in connector is properly mated 2. Check F1 fuse on probe board 3. Check all cable connections 4. Contact factory
MSG-1 <i>Invalid data received from probe(s)</i>	1. Failed RS-485 communications component	1. Check wiring 2. Contact factory
MSG-2 <i>Flow sensor heater "OFF"</i>	1. Blown heater fuse 2. Failed electronic component	1. Contact factory
MSG-3 <i>RS sensor power "OFF"</i>	1. Probe temperature too high 2. Liquid water on probe tips	1. Check that probe temperature is <160°F 2. Contact factory
MSG-4 <i>RS heater "OFF"</i>	1. Component failure	1. Contact factory
MSG-5 <i>Circuit issue</i>	1. Problem with circuitry	1. Contact factory
MSG-6 <i>Temperature alarm (above 210°F/99°C)</i>	1. Steam in exhaust pipe	1. Remove probe or cool line <b>ASAP!</b> 2. Once line has cooled down and probe is reinstalled, check unit for proper function
MSG-7 <i>Wet probe</i>	1. Liquid water on probe tip	1. Remove probe <b>ASAP!</b> 2. Contact factory
MSG-8 <i>RS sensor problem</i>	1. RS sensor problem	1. Remove from line, allow 24 hrs with power on to dry out RS sensor, reinsert probe 2. Contact factory
Mass flow output saturates <b>high</b> , will not respond to flow changes	1. Flow rate is not within range of calibration 2. Blown heater fuse 3. Failed electronic component	1. Contact factory about re-ranging instrument 2. Contact factory
Mass flow output saturates <b>low</b> , will not respond to flow changes	1. Flow rate is not within range of calibration 2. Failed electronic component	1. Contact factory about re-ranging instrument 2. Contact factory

### 4.3.2 Software Communication Problems

When using the *RheoVac* software on a PC, the software may give you a “Communication Error or Message.” Use the information in Table 7 and Table 8 to determine the source of this message and appropriate action.

**Table 7** Troubleshooting Guide (serial connection software communication errors)

OBSERVATION	PROBABLE CAUSE	ACTION
<i>Appears the first time the application was executed</i>	<ol style="list-style-type: none"> <li>1. Instrument not connected to the software defaulted serial port</li> <li>2. Communication connections not made or instrument is not powered</li> </ol>	<ol style="list-style-type: none"> <li>1. Change serial comm port setting and hit “Retry”</li> <li>2. Check connections and instrument power</li> </ol>
<i>Appears intermittently after application has been running normally</i>	<ol style="list-style-type: none"> <li>1. Electrical noise interfering with communications</li> <li>2. Too many applications running in windows</li> <li>3. Another application is conflicting with this comm port or IRQ</li> </ol>	<ol style="list-style-type: none"> <li>1. Change to RS-422 communications, reroute or shield cable</li> <li>2. Close other applications until problem self corrects</li> <li>3. Change to a different comm port</li> </ol>
<i>Completely stops working after application was been running normally</i>	<ol style="list-style-type: none"> <li>1. Instrument has stopped communicating</li> <li>2. Loose or damaged communication connection</li> </ol>	<ol style="list-style-type: none"> <li>1. Check instrument power or look at instrument display for fault status</li> <li>2. Check cable adapter at back of PC or at any other splices or at instrument</li> </ol>
<i>Cannot be made to work at all with Com3 or Com4</i>	<ol style="list-style-type: none"> <li>1. Works fine on Com1 or Com2 but does not work on other port due to other hardware conflicts such as a modem</li> </ol>	<ol style="list-style-type: none"> <li>1. Using Windows Control Panel — System utility, check for IRQ or I/O hardware conflict — ADVANCED USERS ONLY</li> </ol>

Note: Windows is a registered trademark of Microsoft Corporation in the United States and other countries.

**Table 8** Troubleshooting Guide (ethernet connection software communication errors)

OBSERVATION	PROBABLE CAUSE	ACTION
<i>Connection error when attempting to connect to the instrument using the supplied User Interface Software (UIS)</i>	<ol style="list-style-type: none"> <li>1. Incompatible network settings on the User Interface Computer (UIC)</li> <li>2. IP address not identified</li> <li>3. Bad or incompatible Cat5 cable</li> </ol>	<ol style="list-style-type: none"> <li>1. Verify settings on the UIC outlined in Appendix B</li> <li>2. Reboot the UIC and <i>RheoVac</i> Model 950 while connected</li> <li>3. Verify correct Cat5 cable (for peer to peer connection use crossover cable, for networked connection use straight cable)</li> <li>4. Contact factory</li> </ol>
<i>Error occurs when attempting to use the UIS trending option or file update option</i>	<ol style="list-style-type: none"> <li>1. Lost connection</li> <li>2. Incompatible UIS version</li> </ol>	<ol style="list-style-type: none"> <li>1. Restart UIS</li> <li>2. Contact factory</li> </ol>

#### 4.3.3 Primary Signal Validation

If the *RheoVac* instrument is operating without message indications but output readings are questionable, check your *RheoVac* instruments primary readings per Table 9. Please send to Intek by e-mail the following plant data: turbine back pressure, hotwell temperature, load, and inlet and outlet circulating water temperatures, along with at least 24 hours of data from the *RheoVac* instrument/probe for the same time period. A support engineer can examine the data and respond to the inquiry.

**Table 9** Verify Primary *RheoVac* Readings

Pressure, $P_{RV}$ :	Probe pressure should be 0.1" to 0.5"HgA lower than condenser pressure $P_{RV} < P_{Cond}$ (0.1 to 0.5"HgA typical, ~1" HgA under high AIL)
Temperature, $T_{RV}$ :	Probe temperature may be as high as hotwell temperature or as low as circ water inlet temperature; typically a few degrees below circ water outlet temperature and hotwell temperature $T_{cw,in} \leq T_{RV} \leq T_{HW}$ $T_{cw,out} \pm 4^{\circ}F \leq T_{RV} \leq T_{HW}$
Total Mass Flow, $m_T$	$m_T \leq 1,000$ lb/hr (for large exhauster) $225$ lbs/hr $\leq (m)_T \leq 600$ lbs/hr (per exhauster, typical) if $m_T > 1,000$ lb/hr, check <i>RheoVac</i> internal $\Delta T$ ; $> 20^{\circ}F$
Relative Saturation, RS	RS $< 100\%$ and varying; typically 80 to 97%

## 4.4 HARDWARE/SOFTWARE MODIFICATIONS AND UPDATES

#### 4.4.1 Updating Software

Normally, updating the main software residing on the *RheoVac* Model 950 is done at the factory. However, software improvements or other factors may necessitate a user installation or update of a new main program. When this is required, instructions will be supplied, along with the software.

#### 4.4.2 Replacing Probes

If it is necessary to replace one of the probes, a new probe and diskette or CD (with probe-specific calibration data) can be ordered from Intek.

#### 4.4.3 Adding Additional Probes

Each *RheoVac* Model 950 system can communicate with up to three probes simultaneously. Additional probes can be easily added to systems that have fewer than three probes. Each additional probe will be shipped with a set of calibration files that must be installed on the main *RheoVac* instrument electronics. Refer to drawings for mechanical and electrical connections. Specific instructions will be supplied with the probe(s).



## SECTION 5 — CUSTOMER SERVICE FROM THE CONDENSER EXPERTS

Intek's corporate philosophy is to help solve our customers' difficult flow measurement problems. When you purchase a *RheoVac* system you also receive Intek's dedicated customer service. For sales or product service, call your local representative or Intek directly at (614) 895-0301 8AM to 5PM EST/EDT weekdays or fax us anytime at (614) 895-0319. E-mail inquiries should be sent to [sales@intekflow.com](mailto:sales@intekflow.com) or [techsupport@intekflow.com](mailto:techsupport@intekflow.com). Our customer service staff will provide assistance promptly.

### 5.1 QUESTIONS ON EXISTING HARDWARE

To allow us to help you more quickly, please have the serial number of the equipment available before you call.

### 5.2 TROUBLESHOOTING

If you have reviewed SECTION 4.3 TROUBLESHOOTING and have questions, please call our experienced engineers for assistance. In many cases we can solve a problem over the phone. Please provide as complete a description as possible of the problems encountered.

### 5.3 FACTORY AND FIELD SERVICE

If you request field service to help with condenser performance problems, Intek has, for a fee, experienced engineers who can be assigned to meet your needs. For *RheoVac* instrument related questions, if a problem cannot be solved over the phone, with your help, we will determine if factory service or field service will be the best solution. When returning instruments/probes for factory service be sure to carefully pack the instrument/electronics; extra care should be taken to protect the probes from damage in shipment. Use the factory supplied PVC probe protection tube and custom shipping box for probes when possible.

To request factory service on your instrument, a Return Material Authorization (RMA) and purchase order is required. Our customer service staff will assist you with the required information to return equipment for service.

### 5.4 NEW EQUIPMENT AND SERVICES

For information on Intek's power plant instruments and services, such as new *RheoVac* system, condenser flow and fouling meters, liquid or gas flow meter or flow switches, circulating water flow and fouling meters or condenser inspection, analysis, or monitoring services, contact the Intek technical sales department by phone/fax/email. Our staff will be pleased to answer all questions and provide our recommended solutions, instruments, or services.

Intek has developed unique solutions for plants experiencing problems with dissolved oxygen, heat rate and excessive backpressure. We provide comprehensive condenser diagnostic and report services. Plant and *RheoVac* data is automatically transmitted to Intek and results are published via online reporting and regular hard copy reports. Please call us to discuss your observations, concerns, and needs.

Intek has many years of experience helping customers solve their complex condenser problems. Intek's monitoring services ensures plants have expert assistance with collecting, interpreting, and reporting on condenser operations. In many cases, excess back pressure problems can be predicted before have an affect on power production. If you would like a quotation on a complete condenser monitoring and reporting solution, please call.

## 5.5 CONDENSER MANAGEMENT AND *RheoVac* TRAINING

Intek conducts Condenser Operations and Management workshops to educate professionals on *RheoVac* and *Rheotherm* instrumentation as well as condenser operations and theory. During these workshops, degraded condenser performance is discussed including root cause analysis for poor performance and condensate chemistry issues. Solutions are presented and discussed.

Several training tools and reference material can be found on our website, [www.MyCondenser.com](http://www.MyCondenser.com). Tutorials can be found in the help menu, included are presentations on condenser theory, instrumentation, case studies, and condenser services provided by Intek. Posted case studies show events and conditions captured by the *RheoVac* condenser monitor and how the instrument helped troubleshoot or solve upset conditions. Case studies include information on pump issues, air in-leakage events, steam jet air ejector problems, and general condenser performance troubleshooting. Case studies captured by the *Rheotherm* Circulating Water Flow and Fouling Meter are also presented and discussed in the website. Macrofouling, thermal stratification, circulating water pump degradation, and identification of condenser design deficiencies are highlighted.

## SECTION 6 — CUSTOM INFORMATION

### 6.1 UNIT IDENTIFICATION

Model no.: \_\_\_\_\_

Serial no.: \_\_\_\_\_

Customer identification: \_\_\_\_\_

### 6.2 CONFIGURATION

The marked (X) items denote the configuration of this unit as originally shipped from the factory.

Pipe Connection: ☒ Hot tap with 1½" MNPT connection

Input Power: ☒ 100-250 Vac, 50/60 Hz

Outputs:

Analog: ☐ 8 outputs (4-20mA) for each probe

Digital: ☒ Ethernet

☐ RS-232/RS-422

Data Access: ☒ Ethernet communication

Portable Data Storage: ☒ Portable USB Data Storage Device

Enclosures shipped:

- ☒ Processor Box
- ☒ Distribution Box
- ☐ Transmitter Box

Cables Shipped:

- ☒ 5711 interconnect cable (RS485) - \_\_\_\_\_
- ☒ Cat5 Ethernet cable - 10 ft
- ☐ RS232 communication - 20 ft

Software: Windows compatible *RheoVac* 950 system software, — Version 051509  
User interface software on CD — Version 112008

Calibrated for customer line size of \_\_\_\_\_ inches, schedule \_\_\_\_\_

### 6.3 SPECIAL INSTRUCTIONS

The next page shows a sketch of a typical layout for a Model 950 with all components located near each other on the plant floor. Other configurations can be used, but there are rules as to how an RS485 signal can be run, so if you are thinking of using some significantly different arrangement for your installation, please contact the factory (614-895-0301) to review your plans.

## APPENDIX A - *RheoVac*<sup>®</sup> Instrument User Interface Software

### A.1 INTRODUCTION

User Interface Software (UIS) is provided on CD-ROM with every *RheoVac* instrument. This software is used to communicate with the *RheoVac* unit from a User Interface Computer (UIC). Some of the functions of the software can be performed using a serial cable, while all functions are available using an Ethernet connection. An Ethernet crossover cable is provided with each *RheoVac* instrument for the purpose of connecting a UIC directly to the *RheoVac* unit. The network functions are also capable of being used from any network computer if the *RheoVac* instrument is connected directly to the same network. In this case, the supplied crossover cable is not used; rather a straight, high noise-immune Ethernet cable with RJ-45 plug is used (supplied by customer).

Most details regarding use of the software can be found in the active help files from the pull down **Help** menu when using the software.

### A.2 SOFTWARE INSTALLATION

A User Interface Computer (UIC) is required to access stored data and real time data of all parameters. A laptop is suggested for easy access to the main processor unit. Intek does not supply UICs but recommends the following System Requirements (minimum recommended):

Minimum System Requirements:

Windows 98, Windows NT, Windows 2000 or Windows XP Operating Systems

Pentium III, 400 MHZ processor with 128 MB RAM

SVGA 800 x 600 display

One CD-ROM drive

One 10/100 Ethernet Port

Recommended (Optional):

One 3.5 inch floppy disk drive (probe recalibration data files can be provided on diskette)

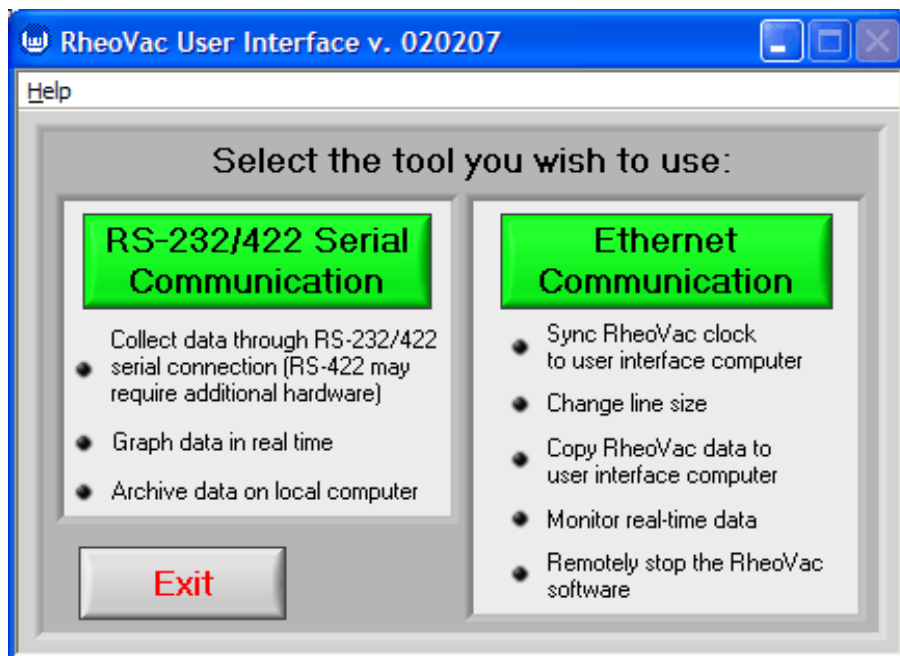
One RS-232 serial port with DB-9 connector

The User Interface Software should be installed onto the User Interface Computer. Install the software by inserting the CD-ROM supplied with the manual into the CD-ROM drive and follow the on screen prompts. A folder, C:\RHEOVAC will be created and files will be copied to this folder. The executable file is **RheoVac User Interface.exe** and the others are drivers and configuration files that must remain in the RHEOVAC folder. If a previous version of User Interface Software is on the UIC, you will need to launch the installer a 2<sup>nd</sup> time.

### A.3 USER INTERFACE SOFTWARE (UIS) SELECTION

After installation, the user interface is initiated by selecting [START\PROGRAMS\RHEOVAC\RHEOVAC USER INTERFACE]. The main menu appears, prompting for a selection of RS-232 Serial Communication or Ethernet Communication Utility. A list of functions for each utility appears below the green selection buttons.

Make sure the proper cable connection has been made and select the desired communication type by clicking on either green button.



**Figure A - Initial UIS computer Screen**

#### A.4 RS-232/422 COMMUNICATION

This function requires a serial cable and connector, available on request, to connect the UIC and the *RheoVac* instrument electronics. This connection allows the user to view real time data of important parameters in a convenient gauge screen layout. From this gauge screen, the user may choose to graph a single parameter for all probes, graph all parameters for a single probe, or archive data directly to the UIC. The archive rate can also be adjusted. These are the only functions available using serial communication. No commands or updates can be sent to the *RheoVac* instrument using this communication method.

#### A.5 ETHERNET COMMUNICATION

User interface using Ethernet connection allows the user to: synchronize the *RheoVac* clock with the UIC clock, retrieve stored data<sup>1</sup>, update files<sup>1</sup>, change line size, and access data. These network access utilities are performed from a user interface computer (UIC) connected directly (peer-to-peer) to the *RheoVac* unit using a crossover network cable or from a network computer when the *RheoVac* instrument is connected to a network (LAN/WAN)<sup>2</sup> using a straight Ethernet cable.

Each *RheoVac* instrument is identified by a unique network ID. The ID begins with the letter “R” followed by the first five digits of the serial number found on the unit. (*RheoVac* Model 950 devices which have not been serviced by the factory since 2005 may use the serial numbers or “*RheoVac*

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<sup>1</sup> File transfer can also be accomplished using Windows Explorer or Network Neighborhood

<sup>2</sup> Specific network set-up at Intek may be required.

950" network ID). The user must select the network ID from the pull down menu following the selection of Ethernet Communication utility from the Main Menu. If the Network ID is not in the list, select Add New ID and enter the correct six character Network ID. When a new ID is added to the list, it will be saved as the default for later use. Selecting the correct ID will initiate communication with the *RheoVac* instrument. Software features, in addition to those detailed above, are described within the User Interface Software itself.

## A.6 SOFTWARE OPERATION

1. Set Clock (available with Ethernet connection only): Initiating this action will reset the *RheoVac* time clock to agree with the time on your UIC. Make sure the UIC has the correct time before proceeding.
2. Change Line Size (available with Ethernet connection only): Use this option to update the instrument's stored line size variable for proper volume and mass flow calculations. You should only need this option if the probe is installed in a pipe size that is different from the value set in the instrument at the factory. In Ethernet Communication, click on the Line Size tab. On the pull down menu for pipe size, click on the new value, then click on **Save**. Click **Load** to verify that the change was saved by the instrument.
3. Update Files (available with Ethernet connection only): If the probes are ever returned for recalibration, or some other change in the *RheoVac* operating software is needed, this tab will be used. Do not use it until then. Instructions will be supplied at that time.
4. Retrieve Data (available with Ethernet connection only): Stored data can be easily accessed via Ethernet connection from the *RheoVac* instrument to the UIC.

The *RheoVac* software creates a new data file each day. The file name is in the following format:

MMDDYY - P.dat

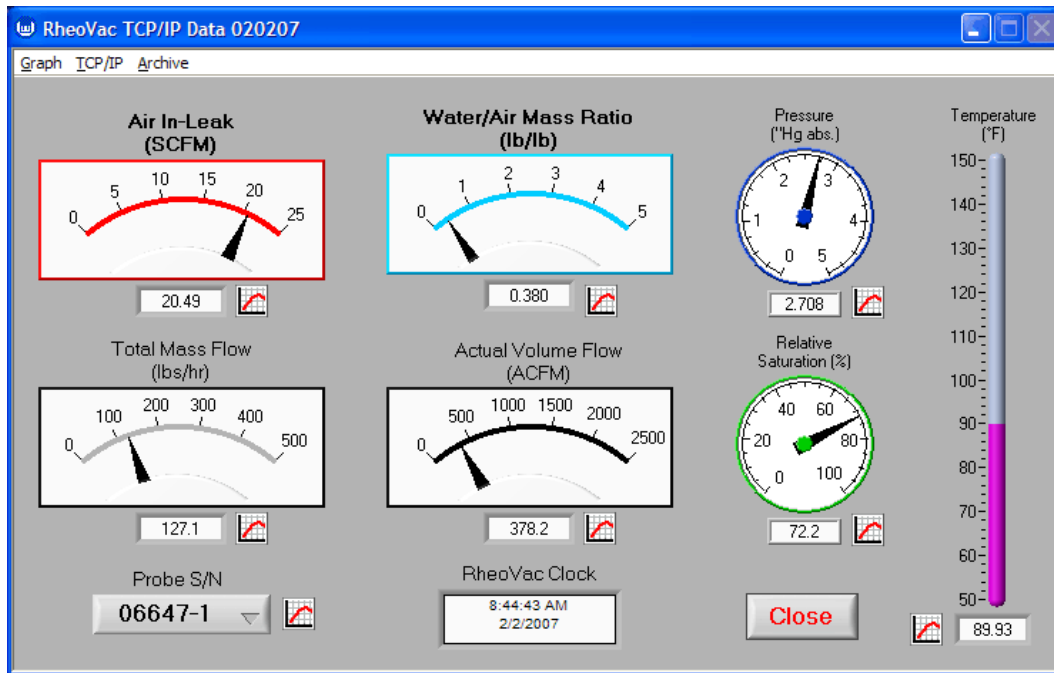
where      MM = two digit month  
             DD = two digit day  
             YY = two digit year  
             P = probe designator (1, 2, or 3)  
             .dat = file extension

These data files are stored in tab delimited text format. See SECTION 3.5 to process data.

To copy a file for analysis, you must access the files on the *RheoVac* instrument. Open Windows Explorer on the UIC. Type \\Network ID\RHEOVAC\DATA (Network ID is generally "R" plus the first 5 digits of the serial number; see section A.5) on the address line and press enter. **Be careful not to alter any support files in this data folder.** Use the copy/paste functions (copy - Ctrl C; paste - Ctrl V) to put data files (.dat) on the UIC.

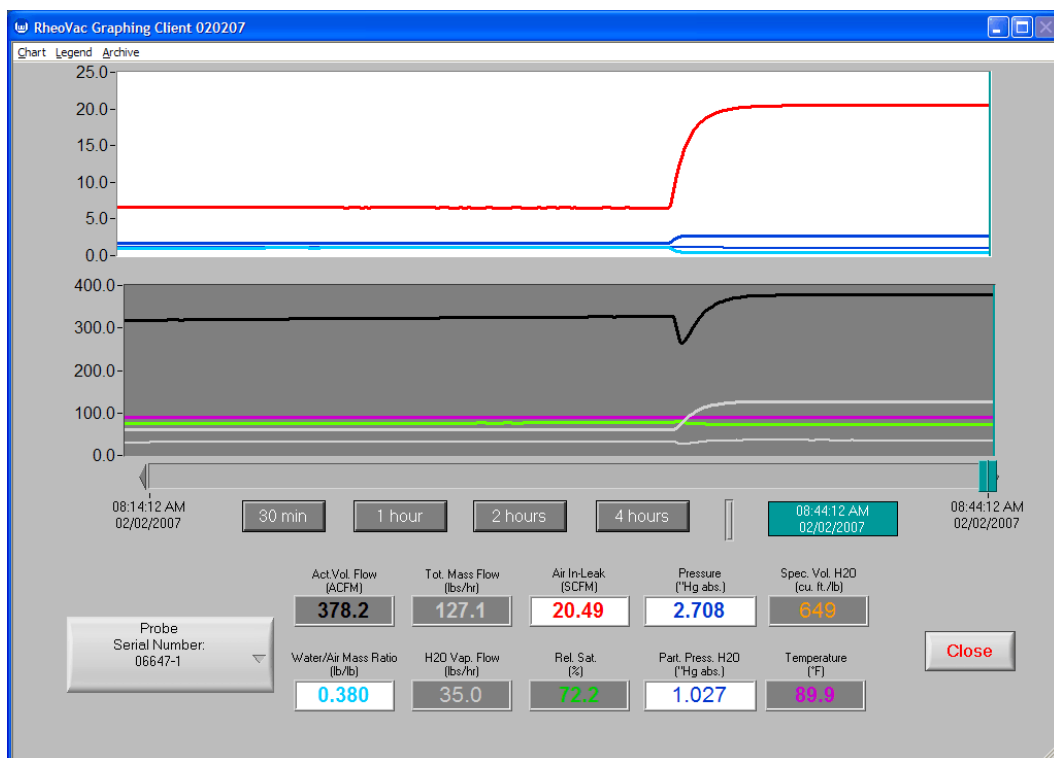
5. Monitor Data (available with Ethernet or RS-232 connection): Once RS-232 or Ethernet is selected, the first screen, Figure B, shows the most recent value for each parameter.

Click on the small graph image to view a historical graph of that parameter. Select from all available probes by clicking on the **Probe S/N** menu.



**Figure B - User Interface Software Data Monitor Feature**

To do real-time graphing, select from the graph menu. The screen shown in Figure C appears.



**Figure C - User Interface Software Graph Feature**

This screen can be divided into four parts:

1. The Chart (or charts)
2. The X-Axis Controls
3. The Legend
4. The User Menu

These four parts work together in the following ways: As soon as the software is opened and valid communication is established, the data collected for each probe is plotted on the chart(s). The newest data points are displayed on the right of the chart and push older data points to the left, much like many old-style strip chart recorders.

The horizontal scroll bar immediately below the chart(s) can be used to select which data points (i.e., data from a specific timestamp) from the chart are displayed on the legend below. Data points can be selected either by clicking-and-dragging the scroll bar pointer or by simply single-clicking a spot on the scroll bar.

The four buttons below and to the left of the scroll bar labeled **30 min**, **1 hour**, **2 hour**, and **4 hour** can be used to quickly set the x-axis range of the chart(s) and the scroll bar. When using these buttons keep in mind that the maximum x-axis value is always used as a reference and only the minimum displayed x-axis value will be changed. You can also change both the minimum and maximum x-axis value by double-clicking them with your mouse and entering a new value with your keyboard. Changing the range of the chart (X or Y axis) changes only the data that is displayed and does not delete or alter the data in any way.

The blue block (time/date) to the right of the **4 hour** button displays the timestamp for the data point currently being pointed to by the horizontal scroll bar. If the scroll bar is in the right-most position, this value will automatically update when new data is received from the connected instrument.

The legend at the bottom of the screen displays the value of the data being pointed to by the scroll bar and also is used to control where each data parameter is plotted. To access this feature single-click on any parameter in the legend. Two things will happen. First, the background color of the selected parameter will change in the legend, and second, the parameter will disappear from the chart if you are in single-chart mode or jump from one chart to the other if you are in dual-chart mode.

Single-chart and dual-chart modes are the first two selections available in the chart user menu. Also available in the chart menu are selections to choose between manual and auto scaling for the y-axis and to reset the maximum x-axis value to the most recently collected data point.

The legend menu is used to select which parameter or which probe is displayed. If a parameter is chosen from this menu, that parameter will be displayed for all probes connected to the instrument. If a probe is selected, then all parameters for that probe will be displayed.

The archive menu is used to set the rate that data will be archived to the hard disk of the computer on which the user has installed the User Interface Software. These selections have no effect on the data that is stored every minute on the hard disk of the *RheoVac* instrument itself. Data archived



to the user's hard disk is stored in the "C:\RHEOVAC\DATA\" directory. The data is subdivided into folders for each probe. A new file for each probe will be created each day that data is archived.

## A.7 WARRANTY REGISTRATION/TECHNICAL SUPPORT

### Sending Data to Intek: **!!!! IMPORTANT !!!!**

If the instrument is equipped with a portable USB data storage device as shown in Figure 5 (in the main manual), remove this storage device after one week of operation and send to "Intek, Inc., 751 Intek Way, Westerville, OH 43082" to activate/secure warranty registration. This storage device is programmed to capture the initial baseline data recorded by the *RheoVac* instrument.

The following paragraph is applicable to *RheoVac* 950 instrument users only:

The availability of plant data for periods corresponding to the *RheoVac* data are important to proper diagnostic evaluation. Plant data of interest to the factory for the same time period are: turbine back pressure, hotwell temperature, load, and inlet and outlet circulation water temperatures. The plant data is necessary for correlating *RheoVac* measured data. The availability of this information at the factory is very important to Intek's ability to assist you in troubleshooting your instrument and/or to respond to inquiries. This provides a baseline for the system and will help us support you should future system problems arise. Our experienced support engineers can access the "before" and "after" effects of an upset and work with you to identify and understand the problem, and develop solutions. Additionally, most air removal piping conditions that are detrimental to probe operation can be diagnosed before probe damage occurs. For this reason, we require a data download one week after the *RheoVac* system is placed into service. The download activates the one year warranty service.

Alternately, you may send to the factory an initial week or so of data (zipped format is preferred). The simplest way is to copy all data files and the 'event.log' file to your UIC and send it via email to techsupport@intekflow.com.

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Note: Windows is a registered trademark of Microsoft Corporation in the United States and other countries.

## APPENDIX B - *RheoVac* Model 950 Networking

### B.1 INTRODUCTION

Use these instructions when making a peer-to-peer Ethernet connection between the *RheoVac* 950 and the User Interface Computer (UIC), or an Ethernet connection between the *RheoVac* 950 and a Local Area Network (LAN). Locate the section that covers your operating software.

### B.2 WINDOWS 98 OR WINDOWS ME OPERATING SYSTEM

1. Ethernet Cable:
  - a. UIC Connection: use CAT5 network crossover cable (supplied by Intek) to connect the Ethernet port of the UIC to the Ethernet port on the *RheoVac* 950.
  - b. LAN Connection: use CAT5 straight high noise-immune Ethernet cable (not supplied) with RJ45 plug to connect the Ethernet port of the LAN to the Ethernet port of the *RheoVac* 950.
2. Workgroup Identification: Unless otherwise requested, the Workgroup identification for the *RheoVac* 950 will be WORKGROUP, which is the Windows 98 default setting. To check/set the workgroup name: Right click on the Network Neighborhood icon on the UIC desktop. Select **Properties** from the menu that appears. Select the **Identification** tab of the Network dialog box that appears. Verify that Workgroup is WORKGROUP.
3. Check for Installed Network Components: Right click on the **Network Neighborhood** icon on the UIC or LAN computer desktop. Select **Properties** from the menu that appears. Select the **Configuration** tab of the Network dialog box that appears. In the list under “The following network components are installed” there should be all three of the following: Client for Microsoft Networks, Ethernet adapter, and NetBEUI (with the Ethernet adapter identified on the same line next to it). Each will have a different icon associated with it; the ‘Client’ icon looks like a computer screen, the ‘Adapter’ icon looks like an adapter card, and the ‘NetBEUI’ protocol icon looks like a cable in a “T” shape. If these components are not installed, one or more of the following installations may be necessary. Note: The Windows installation disk may be needed.
  - a. Installing Client for Microsoft Networks: If Client for Microsoft Networks is not in the list of “The following network components are installed,” then do the following:
    - i. Click the **Add** button next to the list.
    - ii. The Select Network Component Type dialog box will appear.
    - iii. Select **Client** from the list then click the **Add** button.
    - iv. Select **Microsoft** from the Manufacturers list.
    - v. Select **Client for Microsoft Networks** in the Network Clients list.
  - b. Installing NetBEUI: If the NetBEUI (with the Ethernet adapter identified on the same line next to it) is not in the list of “The following network components are installed,” then do the following:
    - i. Search the installed network components list for the installed Ethernet adapter.
    - ii. Select the Ethernet adapter and click the **Add** button below the list.
    - iii. Select **Protocol** from the Select Network Component Type dialog box.
    - iv. Click the **Add** button next to the list.
    - v. The Select Network Protocol dialog box will appear.
    - vi. Select **Microsoft** from the Manufacturers list.
    - vii. Select **NetBEUI** from the Network Protocols list.

4. Networking with the *RheoVac* 950: If all of the items above are completed successfully, the UIC or LAN computer should be able to network with the *RheoVac* 950. To search for the *RheoVac* 950 from the UIC or LAN computer:

#### Method 1

- a. Open **Network Neighborhood**.
- b. Each *RheoVac* instrument is identified by a unique Network ID. The ID is “R” plus the first five digits of the serial number found on the unit. (*RheoVac* Model 950 devices which have not been serviced by the factory since August, 2003 may use the serial numbers or “RheoVac 950” as the Network ID).
- c. Look for the Network ID of your *RheoVac* 950. If the expected Network ID (see previous paragraph) does not show up in the list, then type in the appropriate Address line (either “\\RHEOVAC 950” or “\\R” and the first five digits of the serial number) and click the **Go** button. This may take several seconds and then a RHEOVAC folder will appear, which is the hard drive of the *RheoVac* 950.
- d. Open the RHEOVAC folder then open the DATA folder. The \\Network ID\\RHEOVAC\\DATA folder contains all the stored data. Use copy/paste functions (copy - Ctrl C; paste - Ctrl V) to save the data files to the UIC or LAN computer.

#### Method 2

- a. Open **My Computer**
- b. Type in the Address line: \\Network ID (Network ID is defined above) and click the **Go** button. This may take several seconds and then a RHEOVAC folder will appear, which is the hard drive of the *RheoVac* 950.
- c. Open the RHEOVAC folder then open the DATA folder. The \\Network ID\\RHEOVAC\\DATA folder contains all the stored data. Use copy/paste functions to save the data files to the UIC or LAN computer.

### B.3 WINDOWS NT OR WINDOWS 2000 OPERATING SYSTEM

1. Ethernet Cable:
  - a. UIC Connection: use CAT5 network crossover cable (supplied by Intek) to connect the Ethernet port of the UIC to the Ethernet port on the *RheoVac* 950.
  - b. LAN Connection: use CAT5 straight high noise-immune Ethernet cable (not supplied) with RJ45 plug to connect the Ethernet port of the LAN to the Ethernet port of the *RheoVac* 950.
2. Workgroup Identification: Unless otherwise requested, the Workgroup identification for the *RheoVac* 950 will be WORKGROUP. To check/set the workgroup name: Right click on the **My Computer** icon on the UIC or LAN computer desktop. Select **Properties** from the menu that appears. Select the **Network Identification** tab of the System Properties dialog box that appears. Verify that Workgroup is WORKGROUP.
3. Check for Installed Network Components: Click the **Start** button, select **Settings**, select **Network and Dial-up Connections**. Or, right click **My Network Places** and select **Properties**. Highlight the Local Area Connection that represents the Ethernet adapter. Right click on **Local Area Connection** and select **Properties**. Under “Components checked are used by this connection:” look for **Client for Microsoft Networks** and **NetBEUI Protocol**. If these components are not installed, one or more of the following installations may be

necessary. Note: The Windows installation disk may be needed as well as administrator security rights.

- a. Installing Client for Microsoft Networks: If Client for Microsoft Networks is not in the list of “The following network components are installed,” then do the following:
    - i. Click the **Install** button below the list.
    - ii. The Select Network Component Type dialog box will appear.
    - iii. Select **Client** from the list then click the **Add** button.
    - iv. Select Microsoft from the Manufacturers list.
    - v. Select **Client for Microsoft Networks** in the Network Client list.
    - vi. Click **OK**.
  - b. Installing NetBEUI: If the NetBEUI (with the Ethernet adapter identified on the same line next to it) is not in the list of “The following network components are installed,” then do the following:
    - i. Click the **Install** button below the list.
    - ii. The ‘Select Network Component Type’ dialog box will appear.
    - iii. Select **Protocol** and click the **Add** button.
    - iv. The ‘Select Network Protocol’ dialog box will appear.
    - v. Select **NetBEUI** from the Network Protocol list.
    - vi. Click **OK**.
4. Networking with the *RheoVac* 950: If all of the items above are completed successfully, the UIC or LAN computer should be able to network with the *RheoVac* 950. To search for the *RheoVac* 950 from the UIC or LAN computer:
- a. Open My Computer
  - b. Each *RheoVac* instrument is identified by a unique Network ID. The ID is “R” plus the first five digits of the serial number found on the unit. (*RheoVac* Model 950 devices purchased prior to August, 2003 may use the serial numbers or “RheoVac 950” as the Network ID.)
  - c. Look for the Network ID of your *RheoVac* 950. If the expected Network ID (see previous paragraph) does not show up in the list, then type in the appropriate Address line (either ‘\\RHEOVAC 950’ or ‘\\’ and the first five digits of the serial number) and click the **Go** button. This may take several seconds and then a RHEOVAC folder will appear, which is the hard drive of the RHEOVAC 950.
  - d. Open the RHEOVAC folder and then open the DATA folder. The \\*Network ID*\\RHEOVAC\\DATA folder contains all the stored data. Use copy/paste functions (copy - Ctrl C; paste - Ctrl V) to save the data files to the UIC or LAN computer.

## B.4 WINDOWS XP OPERATING SYSTEM

1. Ethernet Cable:
  - a. UIC Connection: use CAT5 network crossover cable (supplied by Intek) to connect the Ethernet port of the UIC to the Ethernet port on the *RheoVac* 950.
  - b. LAN Connection: use CAT5 straight high noise-immune Ethernet cable (not supplied) with RJ45 plug to connect the Ethernet port of the LAN to the Ethernet port of the *RheoVac* 950.
2. Workgroup Identification: Unless otherwise requested, the Workgroup identification for the *RheoVac* 950 will be WORKGROUP. To check/set the workgroup name: Click the **Start** button and select **Control Panel**. Right click on the **System** icon and select **Open**. Select the **Computer Name** tab. Verify that Workgroup is WORKGROUP. Use the **Change** button to type in a new Workgroup if needed.

3. Check for Installed Network Components: Click the **Start** button and select **Control Panel**. Right click on the **Network Connections** icon and select **Open**. Or, click the **Start** button, select **Connect To**, then select **Show all connections**. Highlight the Local Area Connection that represents the Ethernet adapter. Right click the icon and select **Properties**. In the new window that pops up, under “This connection uses the following items;,” look for Client for Microsoft Networks, NWLink NetBIOS, and NWLink IPX/SPX/NetBios protocols. If these components are not installed, one or more of the following installations may be necessary. Note: The Windows installation disk may be needed as well as administrator security rights.
  - a. Installing Client for Microsoft Networks: If Client for Microsoft Networks is not in the list of “This connection uses the following components;,” then do the following:
    - i. Click the **Install** button below the list.
    - ii. The Select Network Component Type dialog box will appear.
    - iii. Select **Client** from the list then click the **Add** button.
    - iv. Select **Microsoft** from the Manufacturers list.
    - v. Select **Client for Microsoft Networks** in the Network Client list.
    - vi. Click **OK**.
  - b. Installing NWLink NetBIOS: If NWLink NetBIOS is not in the list of “This connection uses the following components;,” then do the following:
    - i. Click the **Install** button below the list.
    - ii. The Select Network Component Type dialog box will appear.
    - iii. Select **Protocol** and click the **Add** button.
    - iv. The Select Network Protocol dialog box will appear.
    - v. Select **NWLink NetBIOS** from the Network Protocol list.
    - vi. Click **OK**.
  - c. Installing NWLink IPX/SPX/NetBIOS: If NWLink IPX/SPX/NetBIOS is not in the list of “This connection uses the following components;,” then do the following:
    - i. Click the **Install** button below the list.
    - ii. The Select Network Component Type dialog box will appear.
    - iii. Select **Protocol** and click the **Add** button.
    - iv. The Select Network Protocol dialog box will appear.
    - v. Select **NWLink IPX/SPX/NetBIOS** from the Network Protocol list.
    - vi. Click **OK**.
4. Networking with the *RheoVac 950*: If all of the items above are completed successfully, the UIC or LAN computer should be able to network with the *RheoVac 950*. To search for the *RheoVac 950* from the UIC or LAN computer:
  - a. Open My Computer.
  - b. Each *RheoVac* instrument is identified by a unique Network ID. The ID is “R” plus the first five digits of the serial number found on the unit. (*RheoVac* Model 950 devices purchased prior to August, 2003 will use the Network ID “RheoVac 950.”)
  - c. Look for the Network ID of your *RheoVac 950*. If the expected Network ID (see previous paragraph) does not show up in the list, then type in the appropriate Address line (either ‘\\RHEOVAC 950’ or ‘\\’ and the first five digits of the serial number) and click the **Go** button. This may take several seconds and then a RHEOVAC folder will appear, which is the hard drive of the *RheoVac 950*.
  - d. Open the *RHEOVAC* folder and then open the DATA folder. The \\Network ID\\RHEOVAC\\DATA folder contains all the stored data. Use copy/paste functions (copy - Ctrl C; paste - Ctrl V) to save the data files to the UIC or LAN computer.

## Appendix C – Optional Features for *RheoVac* Model 950

### Wireless Interface for *RheoVac* Model 950

#### C.1.1 INTRODUCTION

The wireless option for the *RheoVac* Model 950 consists of a high powered 802.11 b/g USB interface antenna connected to the main electronics and a handheld user interface (HUI). With this option installed, users will be able to view real time and graphed measurements from the *RheoVac* probe on the HUI as they move around the plant within the transmission range. The following sections explain the basic operation procedures for the HUI, how to set up the wireless connection and view the data.

#### C.1.2 HANDHELD USER INTERFACE

The HUI interface relies mostly on the touch screen capability. It has 3 buttons to perform various tasks that are outlined below. All other functionality, that is not outlined here, will make use of the touch screen.

##### C.1.2.A The three HUI buttons (Figure C1.1)

1. On/Off/Lock Button
  - a. While *off*, hold this button (1 sec) to turn HUI *on*.
  - b. While *on*, hold this button (3 sec) and slide the bar to turn *off* (Figure C1.2).
  - c. While *on*, press this button once to lock the HUI.
  - d. While locked, press this button once and slide the bar to unlock (Figure C1.2).
2. Home Button
  - a. Pressing this button will take the user back to the home screen (Figure C1.2).
  - b. While locked, press this button once and slide the bar to unlock (Figure C1.2).
3. Volume Toggle – it is used to control volume in audio applications

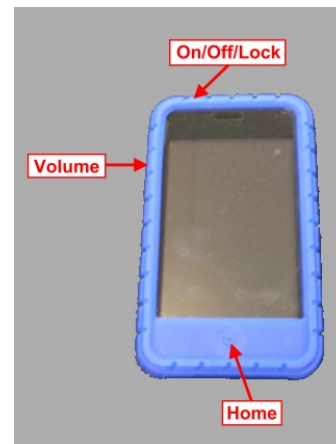


Figure C1.1: Handheld User Interface



Figure C1.2: Common HUI Screens

### C.1.2.B Charging the HUI

A USB cable supplied with the HUI is used for charging and data transfer. The HUI can be charged from any computer with a USB port. The HUI can also be charged from the *RheoVac* Model 950 electronics, as shown in Figure C1.3.



Figure C1.3: Charging the HUI with the *RheoVac* Model 950

### C.1.2.C Using the Touch Screen on the HUI

1. Application selection: This is done by pressing an icon as though it were a button (Figure C1.2 right-most image).
2. Moving the screen: Placing a finger on the screen and dragging the finger moves the screen around. This is used to scroll through the applications, move screens around for full visibility, and browsing pages or documents that cannot be fully displayed on the HUI screen.
3. Zoom in/out: To zoom in, place two fingers on the touch screen and spread them apart. To zoom out, place two fingers on the screen and bring the fingers together.
4. Portrait/landscape view: The HUI can detect whether the screen is right side up or turned 90° and will rotate the viewing screen accordingly. To rotate the screen, simply rotate the HUI 90°.

## C.1.3 THE WIRELESS ANTENNA AND WIRELESS CONNECTION

The wireless antenna is a high powered 802.11 b/g protocol device. It connects to any of the available USB ports on the main electronics as seen in Figure C1.4. This type of antenna is direction sensitive. The typical signal strength and direction is illustrated in Figure C1.5.



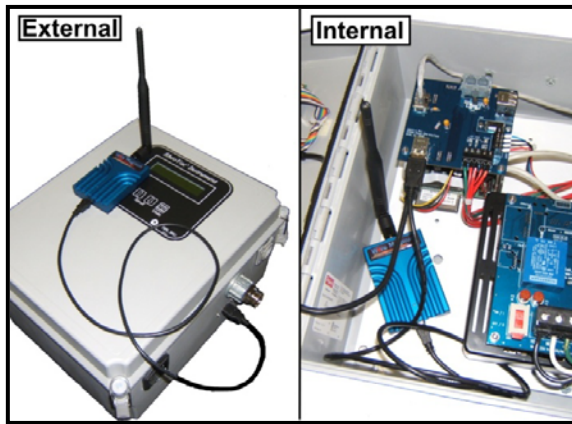


Figure C1.4: Wireless Antenna Connection

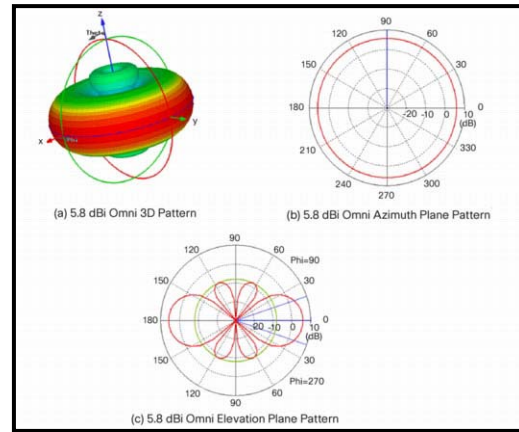







Figure C1.5: Typical Wireless Antenna Signal Range

The following instructions assume the main electronics are *on* and connected to a *RheoVac* probe, the HUI is *on* and unlocked, and that the wireless antenna is connected.

#### C.1.3.A HUI Wi-Fi Settings

1. From the HUI home screen, choose settings .
2. Select Wi-Fi .
3. Under 'Choose a Network', make sure the Rxxxxx\_AP network is selected. (Note: xxxxx is the serial number of the main electronics.)
4. After a short period of time, a Wi-Fi symbol will appear in the upper left corner .
5. Return to the home screen.

#### C.1.3.B Running the Connection Application

1. On the home screen, select the VNC icon .
2. Click/touch the orange button .
3. Select 'RheoVac' from the connection list.
4. The screen will display 'connecting' and 'VNC Negotiating'.

5. The user interface seen in Figure C1.6 will be visible when the HUI is connected. The user interface is designed to be viewed while holding the HUI horizontally in landscape mode.

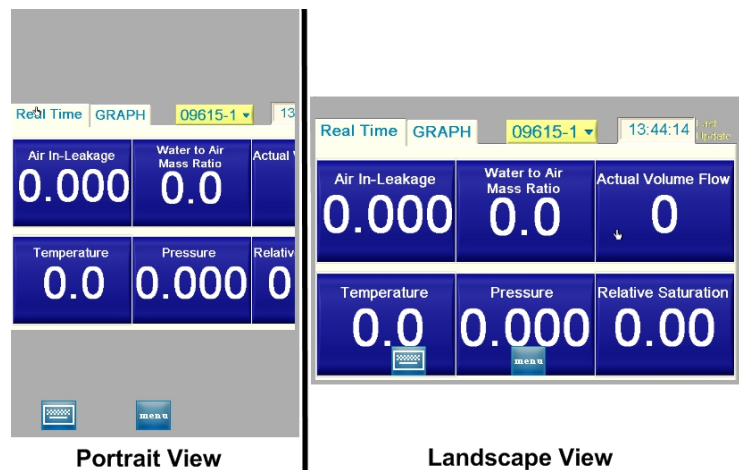


Figure C1.6: *RheoVac* Model 950 User Interface

#### C.1.4 USING THE USER INTERFACE

Basic Features – The display screen shows the following function fields: real time and graphing tabs, probe under view, last update time, keyboard, and VNC menu.



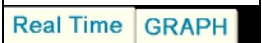

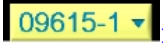


- C.1.4.A Real time display tab : Six parameters are displayed on the screen. Click/touch any of the displayed values to switch to the plotting view.
- C.1.4.B Graphing tab : It is used for real time trending of *RheoVac* outputs. To change X-axis scale and Y-axis limits, see Figure C1.7, 1<sup>st</sup> and 2<sup>nd</sup> columns
- C.1.4.C Probe under view : To change probe under view, see Figure C1.7, 3<sup>rd</sup> column.
- C.1.4.D Keyboard : Selecting this button opens a QWERTY keyboard on your screen that is used to change values on the Y-axis, see Figure C1.7, 2<sup>nd</sup> column.
- C.1.4.E VNC Menu : Selecting this button opens the screen shown in Figure C1.8. From this menu, you can disconnect or refresh the connection.



Figure C1.7: Customizable User Interface Features



Figure C1.8: VNC Application Menu

## Serial Modbus for *RheoVac* Model 950

### C.2.1 INTRODUCTION

Modbus protocol is a messaging structure developed by Modicon in 1979. It is used to establish master-slave/client-server communication between intelligent devices. Modbus is used in multiple master-slave applications to monitor and program devices, to communicate between intelligent devices and sensors and instruments, to monitor field devices using PCs and HMIs.

The *RheoVac* Model 950 supports the Modbus protocol over RS-232, acting as a slave device. There are many existing commercial products that function as a Modbus master, allowing for data collection from the *RheoVac* Model 950 using serial Modbus. Detailed information on the Modbus protocol can be found at [www.modbus.org](http://www.modbus.org).

### C.2.2 SUPPORTED MODBUS FUNCTIONS

The *RheoVac* Model 950 supports the following Modbus function codes:

- 03 (0x03) Read Holding Registers
- 06 (0x06) Write Single Register
- 08 (0x08) Diagnostics

All of the *RheoVac* Model 950 data available via serial Modbus exists as Modbus registers (16-bit values). Modbus coils (1-bit values) are not used in any way. Most of the registers are read-only, with the exception of the Modbus server global settings discussed in **Section C.2.3**. Functions 03 and 06 are used to read and write registers, respectively. Function 08 can be used to test connectivity, as it will produce a reply from the *RheoVac* Model 950 identical to the sent packet.

### C.2.3 MODBUS SERVER GLOBAL SETTINGS

A number of global settings are used to configure the *RheoVac* Model 950 serial Modbus server. Many of these settings can be adjusted by the end user to facilitate integration of a *RheoVac* Model 950 with an existing Modbus network. **Table C2.1** lists the *RheoVac* Model 950 serial Modbus global settings and their default values.

The settings can be modified in two ways: either by modifying a configuration file within the *RheoVac* Model 950 or by sending a properly formatted Modbus Function 06 message to write the address listed in **Table C2.1**. Refer to **Section C.2.6** for more information on modifying the configuration file within the *RheoVac* Model 950.

Ten different process variables (PVs) are produced by the *RheoVac* Model 950 serial Modbus server. These values take one of the two formats: multiplied integer or single float. The “Conversion Mode” (Register 0009) setting listed in **Table C2.1** determines the data format used for the PVs. In multiplied integer mode, the *RheoVac* 950 data values are multiplied by a power of ten specified in a set of additional registers. The resulting values are then transmitted as 16-bit unsigned integers. In single float mode, all of the data values are converted into a 4-byte hexadecimal string corresponding to their single-precision float representation.

**Table C2.1: Modbus Server Global Settings**

Address	Description	Allowed Values	Default	Format	Read Only?
0001	Restart Modbus Server	Write '1' to restart	0	16-bit unsigned	No
0002	<i>RheoVac</i> Serial Port	Set to '0' internally by <i>RheoVac</i> System	0	16-bit unsigned	Yes
0003	Baud Rate	2400,4800,9600,14400,19200 bps	9600	16-bit unsigned	No
0004	Data Bits	7 or 8	8	16-bit unsigned	No
0005	Stop Bits	0 = 1 stop bit 1 = 1.5 stop bits 2 = 2 stop bits	2	16-bit unsigned	No
0006	Parity	0 = No Parity 1 = Odd Parity 2 = Even Parity 3 = Mark Parity 4 = Space Parity	0	16-bit unsigned	No
0007	Modbus Address	1 – 255	1	16-bit unsigned	No
0008	Communication Mode	0 = ASCII 1 = RTU	0	16-bit unsigned	No
0009	Conversion Mode	0 = Multiplied Integer 1 = Single Float	0	16-bit unsigned	No
0010	Number of Probes	1 – 3	1	16-bit unsigned	Yes

### C.2.3 MODBUS DATA SETTINGS (Multiplied Integer Mode)

The values listed in **Table C2.2** are used only when the Modbus server is in “Multiplied Integer” mode (“0” written to register 09). These register values determine the power of 10 that is used to multiply each parameter (effectively shifting the decimal point) before it is transmitted as a 16-bit unsigned integer.

**Table C2.2: Modbus Data Multiplier Registers**

Address	Description	Allowed Values	Default	Read Only?
0011	Multiplier power for Actual Volume Flow	0 – 3	16-bit unsigned	No
0012	Multiplier power for Total Mass Flow	0 – 3	16-bit unsigned	No
0013	Multiplier power for Water Vapor Flow	0 – 3	16-bit unsigned	No
0014	Multiplier power for <i>RheoVac</i> Pressure	0 – 3	16-bit unsigned	No
0015	Multiplier power for Water Vapor Specific Volume	0 – 3	16-bit unsigned	No
0016	Multiplier power for Water Vapor to Air Mass Ratio	0 – 3	16-bit unsigned	No
0017	Multiplier power for Relative Saturation	0 – 3	16-bit unsigned	No
0018	Multiplied power for Water Vapor Partial Pressure	0 – 3	16-bit unsigned	No
0019	Multiplier power for Air Flow In-Leak	0 – 3	16-bit unsigned	No
0020	Multiplier power for Probe Temperature	0 – 3	16-bit unsigned	No

### C.2.4 MODBUS DATA REGISTERS (Multiplied Integer Mode)

When in Multiplied Integer mode, the *RheoVac* 950 data values are multiplied by a power of ten specified in the registers listed in **Table C2.2**. The resulting values are then transmitted as 16-bit unsigned integers. Each value therefore needs only 1 register (2 bytes) of allocated space. In this mode, the data registers are allocated in pairs, with each data value followed by the multiplication power corresponding to it. For example, assuming all multiplier registers are set to 3, the *RheoVac* Pressure is transmitted as follows:

*RheoVac* Pressure (probe reading) = 1.257

Register 117 (*RheoVac* Pressure) = 1257

Register 118 (Multiplier Value) = 3

To allow for future expansion and up to three different probes, each probe is allocated a space of 100 registers, with the registers for the first probe beginning at address 0101. Registers for the second probe begin at address 0201, and the third probe begins at register address 0301. **Table C2.3** details the *RheoVac* Model 950 data register setup when in Multiplier Integer mode.

**Table C2.3: Modbus Data Registers (Multiplied Integer Mode)**

Address	Description	Format	Read Only?
0101 – 0105	Probe Serial Number	10 ASCII characters	Yes
0106	Error Code: see <b>Section C.2.6</b>	16-bit unsigned	Yes
0111	Actual Volume Flow	16-bit unsigned	Yes
0112	Multiplier Value	16-bit unsigned	Yes
0113	Total Mass Flow	16-bit unsigned	Yes
0114	Multiplier Value	16-bit unsigned	Yes
0115	Water Vapor Flow	16-bit unsigned	Yes
0116	Multiplier Value	16-bit unsigned	Yes
0117	<i>RheoVac</i> Pressure	16-bit unsigned	Yes
0118	Multiplier Value	16-bit unsigned	Yes
0119	Water Vapor Specific Volume	16-bit unsigned	Yes
0120	Multiplier Value	16-bit unsigned	Yes
0121	Water Vapor to Air Mass Ratio	16-bit unsigned	Yes
0122	Multiplier Value	16-bit unsigned	Yes
0123	Relative Saturation	16-bit unsigned	Yes
0124	Multiplier Value	16-bit unsigned	Yes
0125	Water Vapor Partial Pressure	16-bit unsigned	Yes
0126	Multiplier Value	16-bit unsigned	Yes
0127	Air Flow In-Leak	16-bit unsigned	Yes
0128	Multiplier Value	16-bit unsigned	Yes
0129	Probe Temperature	16-bit unsigned	Yes
0130	Multiplier Value	16-bit unsigned	Yes

## C.2.5 MODBUS DATA REGISTERS (Single Float Mode)

In Single Float mode, all of the data values are converted into the 4-byte, big-endian hexadecimal string corresponding to their single-precision float representation. The Modbus client program must be capable of converting these 4-byte values back into single-precision float values. If the client software is unable to make this conversion, the Multiplied Integer mode must be used. Data in the Single Float mode is transmitted as follows:

*RheoVac* Pressure (probe reading) = 1.257

Single-Float Hex Representation = 0x3FA0E560

Register 117 (high word) = 0x3FA0

Register 118 (low word) = 0xE560

As in the Multiplied Integer mode, each probe is allocated a space of 100 registers, with the registers for the first probe beginning at address 0101. Registers for the second probe begin at address 0201, and the third probe begins at register address 0301. **Table C2.4** details the *RheoVac* Model 950 data register setup when in Single Float mode.

**Table C2.4: Modbus Data Registers (Single Float Mode)**

Address	Description	Format	Read Only?
101 – 105	Probe Serial Number	10 ASCII characters	Yes
106	Error Code: see <b>Section C.2.6</b>	16-bit unsigned	Yes
111 – 112	Actual Volume Flow	Single-Precision Float	Yes
113 – 114	Total Mass Flow	Single-Precision Float	Yes
115 – 116	Water Vapor Flow	Single-Precision Float	Yes
117 – 118	<i>RheoVac</i> Pressure	Single-Precision Float	Yes
119 – 120	Water Vapor Specific Volume	Single-Precision Float	Yes
121 – 122	Water Vapor to Air Mass Ratio	Single-Precision Float	Yes
123 – 124	Relative Saturation	Single-Precision Float	Yes
125 – 126	Water Vapor Partial Pressure	Single-Precision Float	Yes
127 – 128	Air Flow In-Leak	Single-Precision Float	Yes
129 – 130	Probe Temperature	Single-Precision Float	Yes

## C.2.6 RHEOVAC INSTRUMENT ERROR CODE

The error code address will return 4 ASCII characters (ASCII Mode) or 2 Hex bytes (RTU Mode) that represent a binary number. A value of 1 in the binary representation will indicate a specific error depending on the location of the 1 in the binary number as described in **Table C.2.5**. Examples are shown in **Table C.2.6**.

**Table C2.5: Modbus Error Code Decryption Table**

Error Indication	CalX	MSG8	MSG7	MSG6	MSG5	MSG4	MSG3	MSG2	MSG1	MSG0
Binary Value	0 or 1	0 or 1	0 or 1	0 or 1	0 or 1	0 or 1	0 or 1	0 or 1	0 or 1	0 or 1

**Table C2.6: Modbus Error Examples**

ASCII Mode Output (data portion only)	RTU Mode Output (data portion only)	Binary Representation	Indicated Error Messages
30 30 30 30	00 00	0000 0000 0000 0000	No errors
30 30 30 31	00 01	0000 0000 0000 0001	MSG0
30 30 34 43	00 4C	0000 0000 0100 1100	MSG6, MSG3, MSG2
30 31 43 41	01 CA	0000 0001 1100 1010	MSG8, MSG7, MSG6, MSG3, MSG1
30 33 30 34	03 04	0000 0011 0000 0100	CalX, MSG8, MSG2

## C.2.7 MODIFYING THE MODBUS CONFIGURATION FILE

To modify the configuration file, the *RheoVac* Model 950 must be attached to a local network. Once connected, Windows Explorer can be used to browse into the *RheoVac* Model 950 similar to a PC. Using the name of the *RheoVac* Model 950 as the Network ID, the Modbus settings file can be found at the following location:

[\\<NETWORK\\_ID>\RheoVac\init\serial.ini](#)

**Figure C2.1** shows a sample serial.ini file. The Modbus settings are listed under the section titled “[Modbus]”. In addition, when the Modbus “Mode” setting is 0 (Multiplied Integer), the settings listed under the “[DecLoc]” section define the decimal location for each of the 10 process variables. These values can be changed to fit the needs of the existing serial Modbus network. Once the changes have been made and the file has been saved in its current location, the *RheoVac* Model 950 must be rebooted

using the 3-button simultaneous push “Close RV950: System Will Reboot” function or a power cycle for the changes to take effect.

**CAUTION:** Modifying any of the other settings in this file could result in undesired behavior.

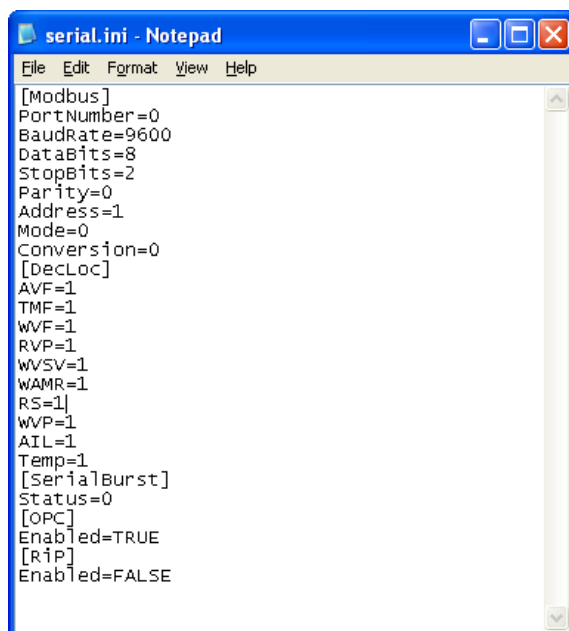


Figure C2.1: Sample serial.ini file

## C.2.8 MODBUS TROUBLESHOOTING

Problem	Causes	Solution
No response from RheoVac Model 950	<ol style="list-style-type: none"> <li>1. System not set for Modbus communication</li> <li>2. Incorrect Modbus settings</li> <li>3. Improper wiring</li> </ol>	<ol style="list-style-type: none"> <li>1. See Figure C2.1, verify [SerialBurst], Status=0 is set in Serial.ini</li> <li>2. Verify settings in serial.ini file, se Table C2.1</li> <li>3. Verify wiring connections</li> </ol>
Not enough data resolution in Multiplied Integer mode	<ol style="list-style-type: none"> <li>1. Non-optimal multiplier values set</li> </ol>	<ol style="list-style-type: none"> <li>1. Change the multiplier values in the serial.ini file located under [DecLoc]</li> <li>2. Set the values in address registers 0011 - 0020</li> </ol>
Multiplier values are changing	<ol style="list-style-type: none"> <li>1. The RheoVac instrument has overflow protection built in. When [process variable]*[multiplier value] exceeds 65535, the instrument automatically lowers the multiplier value to retain usable output.</li> </ol>	<ol style="list-style-type: none"> <li>1. Request the multiplier value along with process data rather than hard coding the multiplier value in the client software</li> <li>2. Lower the multiplier value for each process variable that reaches the overflow state</li> <li>3. Use single precision float mode instead of multiplied integer mode</li> </ol>
Receiving incorrect error codes	<ol style="list-style-type: none"> <li>1. Some client software automatically inverts the binary representation of the error code hex value</li> </ol>	<ol style="list-style-type: none"> <li>1. Revert the binary representation</li> <li>2. Reverse the order of error messages in Table C2.5</li> </ol>



## OPC for *RheoVac* Model 950

### C.3.1 INTRODUCTION

The *RheoVac* Model 950 also incorporates an OPC Server to provide access to Process Variables (PVs) through the OPC standard. OPC provides the functionality for accessing (reading and writing) data from various networked devices via a standard set of interfaces. The primary intent of OPC is to provide the interfaces for data acquisition in support of the vertical architecture (serve data from a device to a client application on a higher level computer)

In order to access data, an OPC client application needs to specify the following:

- The name of the OPC Server
- The name of the machine hosting the OPC Server
- The vendor specific OPC Item Definition (a.k.a. OPC Tag)

### C.3.2 OPC ITEM DEFINITION

For each probe attached to a *RheoVac* Model 950, 11 Process Variables (PVs) are available through OPC. Three OPC tags are published for each of the 11 PVs: Label, Units, and Value. The “Label” and “Units” tags are strings that represent the current label and units for each PV. The “Value” tag contains the actual 8-byte, double-precision float value corresponding to the PV. The OPC tags for these PVs follow a basic path structure as follows:

- <OPC Machine Name>\<OPC Server Name>\<Probe Name>\<PV#>\Label (string)
- <OPC Machine Name>\<OPC Server Name>\<Probe Name>\<PV#>\Units (string)
- <OPC Machine Name>\<OPC Server Name>\<Probe Name>\<PV#>\Value (double)

For each *RheoVac* Model 950, the basic path structure above must be customized according to the following rules in order to access OPC data:

- <OPC Machine Name> corresponds to the Network ID for the *RheoVac* Model 950 (without the “<”, “>” characters).
- <OPC Server Name> is always “**OPC\_Intek-exe**” (without the “<”, “>” characters).
- <Probe Name> corresponds to the individual probe name (without the “<”, “>” characters).
- <PV#> is one of “PV1”, “PV2”, “PV3”,... “PV11” depending on the desired PV (without the “<”, “>” characters).

The individual PVs are listed in **Table C2.5**.

**Table C2.5: OPC Process Variable List**

Tag Name	Description
PV1	<i>RheoVac</i> Time Stamp
PV2	Actual Volume Flow
PV3	Total Mass Flow
PV4	Water Vapor Flow
PV5	<i>RheoVac</i> Pressure
PV6	Water Vapor Specific Volume
PV7	Water Vapor to Air Mass Ratio
PV8	Relative Saturation
PV9	Water Vapor Partial Pressure
PV10	Air Flow In-Leak
PV11	Probe Temperature

As an example, consider a *RheoVac* Model 950 with the Network ID “r09613” and two probes connected with names of “99261-1” and “99261-2”. The following OPC connection strings would be used to read the Pressure (PV5) and Relative Saturation (PV8) from each probe:

- R09613\OPC\_Intek-exe\99261-1\PV5\Value
- R09613\OPC\_Intek-exe\99261-1\PV8\Value
- R09613\OPC\_Intek-exe\99261-2\PV5\Value
- R09613\OPC\_Intek-exe\99261-2\PV8\Value

**Note:** If the *RheoVac* Model 950 is attached to a network that does not support DNS, the IP Address for the unit must be used instead of the Network ID.

## C.4 Downloading Data from your *RheoVac* 950 Instrument

### C.4.1 INTRODUCTION

The data stored in your *RheoVac* instrument can be downloaded to a USB memory device, or connected to a laptop for download.

### C.4.2 DOWNLOADING DATA TO USB MEMORY DEVICE

A USB memory stick can be found in the *RheoVac* Model 950 instrument’s main electronics enclosure, secured to the inside of the enclosure lid. For normal operation of the system the memory stick does not need to be installed in the USB port. *RheoVac* data is stored by the instrument on its internal system drive. Use the following steps when data needs to be retrieved from the instrument:

1. Install the USB memory stick into the USB port labeled CN2. (Figure C4.1)

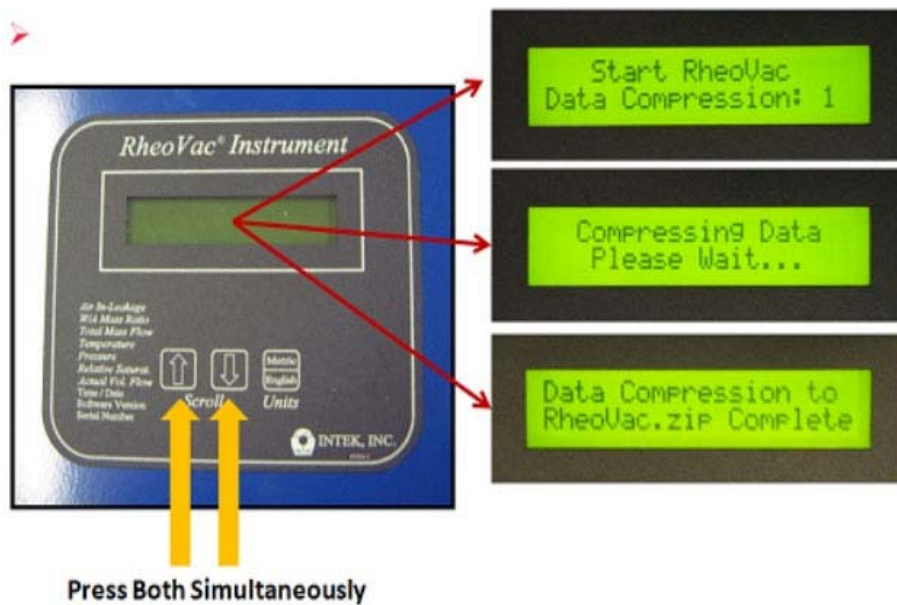


2008 and newer systems have a VGA adapter on the PWA assembly with the USB adapters

**Figure C4.1**

2. Wait at least one minute for the system to locate and update the driver.
3. On the front panel keypad, press both the UP and DOWN arrows (Figure C4.2) at the same time and hold for one second. The entire *RheoVac* 950 system will be compressed and saved to the USB stick. FILENAME: RHEOVAC.ZIP. If multiple *RheoVac* Systems are going to be downloaded ensure a different USB stick is used for each system to prevent over writing data.





**Figure C4.2**

4. Copy the RHEOVAC.zip file to a computer for analysis. For data plotting, tools are available at [www.MyCondenser.com](http://www.MyCondenser.com). For further support email data and questions to [techsupport@intekflow.com](mailto:techsupport@intekflow.com); a service contract may be required.
5. Replace USB stick to its storage position inside lid of the electronics enclosure.