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Manual no. RVAC Rev. D
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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.

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SECTION 1 — GENERAL INFORMATION

1.1 INTRODUCTION

For the first time, all necessary properties of the fluid in the condenser exhauster line are directly measured to provide an accurate determination of air in-leakage. These properties are measured to provide the power industry with the most advantageous and complete product for condenser system diagnostics:

— the *RheoVac*® Air In-Leak Monitor System*

*USPNs 5,485,754; 5,752,411

The *RheoVac* air in-leak monitor system consists of multiple sensors configured in a single probe head and an electronic signal conditioner and digital signal processor (DSP) unit. The sensing probe is installed in the vacuum line between the condenser and the exhauster. The *RheoVac* monitor is superior to all other methods in that it makes no assumptions about the dynamic condenser and vacuum line environment. The sensor head employs the patented Rheotherm® technology to provide an accurate flow measurement. Additionally, temperature, pressure and water vapor relative saturation measurements are made using a high accuracy platinum resistance temperature detector (RTD), a strain gauge pressure sensor and a specially configured and calibrated water vapor saturation sensor.

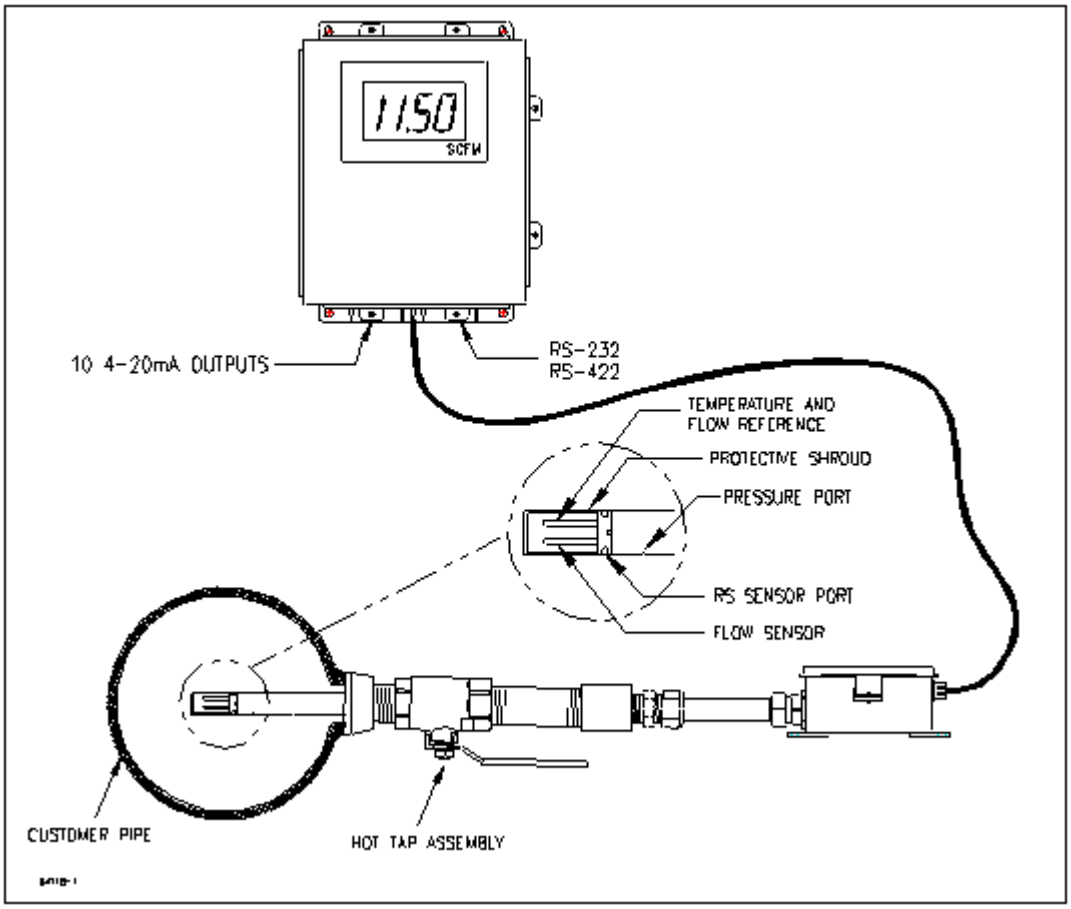


Figure 1 *RheoVac* Air In-Leak Monitor

1.2 PRINCIPLE OF OPERATION

The principal features of the *RheoVac* monitor are shown in Figure 1. At the heart of the *RheoVac* monitor is the Rheotherm flow transducer which uses the same patented thermal sensing technique employed in all precision flow instruments manufactured by Intek. Two temperature sensor probes are used — one sensor is in thermal equilibrium with the flow medium and provides a temperature and flow signal reference, while the second sensor is located near a constant power probe heater so that its temperature is always above that of the fluid. The temperature of the heated sensor will vary with the stream velocity of the fluid. Hence, the measured temperature differential between the reference sensor and heated sensor is a function of flow rate, which is approximately proportional to the logarithm of mass flow rate (USPN 4,255,968).

The Rheotherm flow sensor is calibrated to measure the total mass flow of the water vapor/air mixture. From the other three measurements, the *RheoVac* electronics converts the total mass flow signal from the transducer into two components, air mass flow rate and water vapor mass flow rate. This unique measurement method is disclosed in two separate patents (USPN 5,485,754 & 5,752,411).

The *RheoVac* monitor is fully calibrated in the factory under dynamic fluid conditions identical to those within the power plant vacuum line. No field adjustments are required.

1.3 TECHNICAL SPECIFICATIONS

Primary Calibration Accuracy:
±1% of reading
Repeatability:
±0.5% of reading
Operating Temperature:
Electronics: –20 to 120°F
Transducer: 40 to 160°F
Never subject transducer to temperatures above 210°F
Operating Pressure:
0 to 10 inches Hg absolute
Process Connection:
Hot tap assembly
(1½" thread-o-let must be welded to pipe for hot tap installation)

Wetted Surface:
300 Series SS and engineering plastic
Local Display:
air in-leakage (SCFM)
Input Power:
115 Vac, 50/60 Hz (±15V)
230 Vac, 50/60 Hz (±15V)
Signal Output:
4/20 mA (for 10 parameters)
RS 232/422
Storage Temperature:
–20 to 120°F
Storage Pressure:
15 psig (maximum)

1.4 PRECAUTIONS

- Read the entire manual before installing and operating the *RheoVac* monitor.
- Carefully select the best location for installation of the transducer probe. Adequate straight run and freedom from standing water in the line are vital to achieving optimal performance from the *RheoVac* monitor (See Figure 2).
- Use reasonable care in handling the transducer — the sensing components are delicate. Take care not to bend the probes, damage the tips, or otherwise obstruct the sensing ports.

- Use proper input power — check the power select switch position on the electronics. Select either 115 Vac or 230 Vac before applying power.

- Check the transducer maximum temperature and pressure ratings — never operate a transducer at or subject it to temperatures or pressures beyond its specified limits.

  !! !! WARNING - Never allow live high temperature steam to flow either direction in the exhauster line where the probe is located.

- Keep moisture out of the enclosures — once all service connections are made, make sure the enclosure lids are tightly closed and all gaskets are in place. Seal conduit lines at the instrument.

SECTION 2 — INSTALLATION

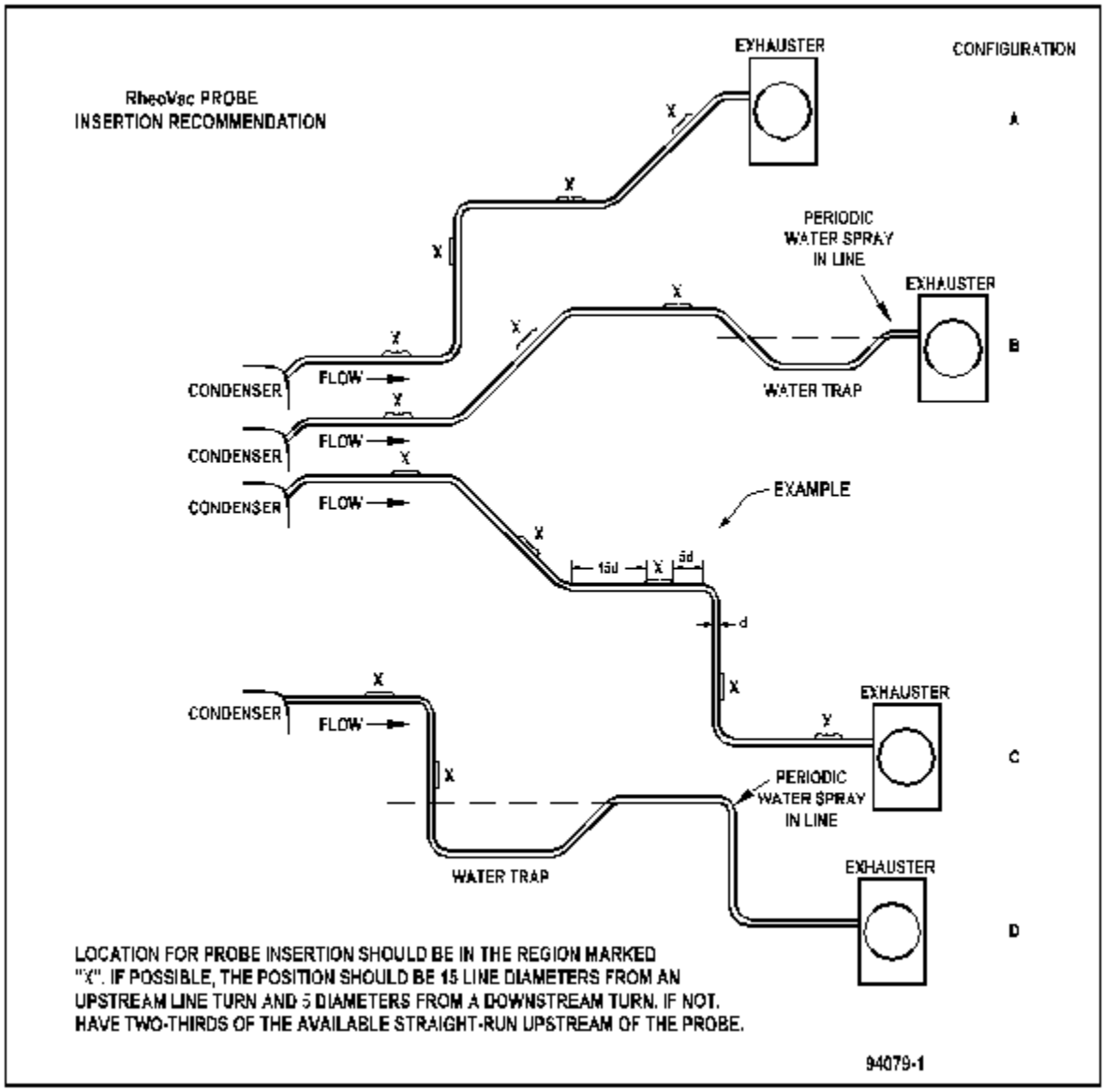


Figure 2 *RheoVac* Probe Insertion Recommendation

2.1 INTRODUCTION

These instructions cover installation of the *RheoVac* monitor in its standard configuration. Additional information pertaining to your unit is covered in SECTION 6 — CUSTOM INFORMATION. Carefully read these instructions prior to installing the equipment.

2.2 *RheoVac* MONITOR INSTALLATION/SITE SELECTION

2.2.1 Transducer Site Selection

- Select the installation site. The location should provide the transducer sensing area with well-established smooth flow, uniform system temperature and pressure, and consistent non-liquid phase flow medium. Pipe sections ahead of probe, in which water can accumulate, must be avoided. Refer to Figure 2 and select the most preferred location that fits your vacuum line configuration. Do not install the probe 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 any special instructions.

- Check installation clearance. The transducer probe is almost 3 feet long and the hot tap assembly is about 13" long, so allow 4 feet of clearance for probe installation. Be sure there are no obstructions around the vacuum line that will interfere with transducer insertion. Figure 3 shows the proper insertion angle. THIS ORIENTATION IS IMPORTANT FOR PROPER OPERATION.

- OBSERVE the selected site. It should be convenient for removal and replacing probe at any time for service without building scaffolding or waiting for plant shutdown.

- Check operating conditions. The temperature and pressure limits of the unit should be checked to ensure compatibility with your application.

2.2.2 Electronics Unit Site Selection

- Select the installation site. The electronics unit should be located in a dry area. The electronics are not protected against condensed liquid water inside the enclosure.

- Check for input voltage access. The electronics unit should be located in an area with access to a 115 Vac or 230 Vac single phase, 50-60 Hz input power source.

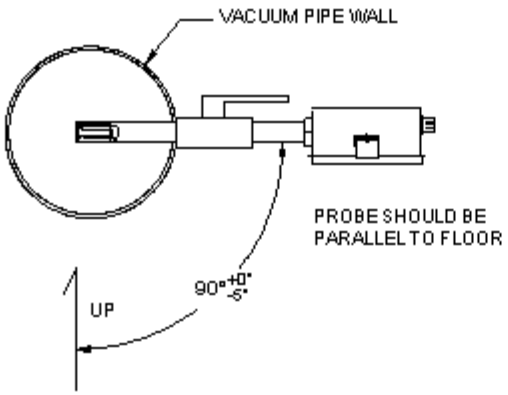
- Check cable distances. The distances from the transducer to the electronics unit and from the electronics unit to the control room, or to the receiving equipment serial communications port or to the analog input device, should not exceed the distances shown in Figure 4.

- Check electronics enclosure mounting area requirements. The *RheoVac* electronics enclosure is NEMA 4, measuring 12"×10"×5". A detailed drawing of the mounting interface is shown in Figure 5 (pg. 7).

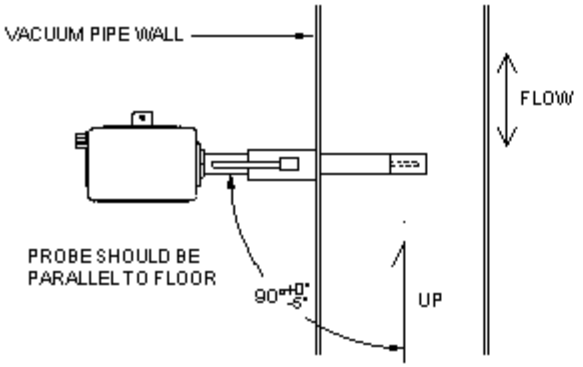
- Check for accessibility to setup and use a portable computer (PC) at the site for trouble-shooting. There should be a place to set up the PC and to open the electronics enclosure.

REVISIONS			
REV	DESCRIPTION	DATE	APVD
A	EDITING CHANGES	11/18/97	MH
B	Changed installation angle	11/15/99	

REQUIRED INSTALLATION ANGLE
FOR HORIZONTAL PIPE RUN

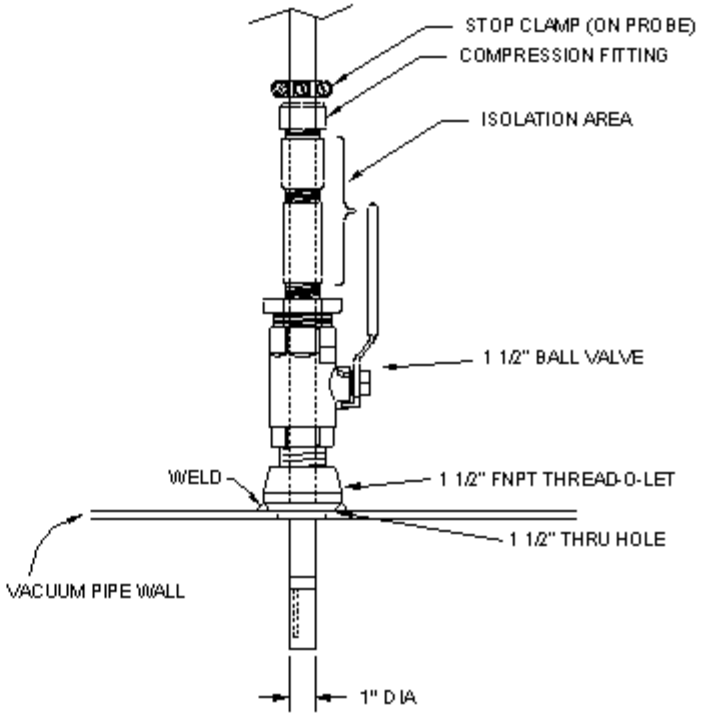


REQUIRED INSTALLATION ANGLE
FOR VERTICAL PIPE RUN



TRANSDUCER

HOT TAP INSTALLATION
(INSERTION ANGLE NOT SHOWN)



UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ON: FRACTIONS = ± N/A DECIMALS X = ±N/A XX = ±N/A XXX = ±N/A ANGLES = ± N/A	DATE 10/03/95	Intek, Inc. 751 Intek Way Westerville, Ohio 43082	
	DRAWN JVR		
	CHKD		
	APVD	RheoVac®	
	APVD	TRANSDUCER INSTALLATION DETAIL	
	PROGRAM:	SIZE A / CAGE CODE 59936	DRAWING No. 94078-3
FILE 94078-3	CONTR	SCALE 1:1	SHEET 1 OF 1 / MOD NO.

Transducer Installation Detail

2.3 MOUNTING HARDWARE INSTALLATION

① Check hardware. Verify that the probe slides through the hot tap assembly.

② Check installation configuration. Make sure the probe is parallel to the floor. (see Figure 3).

③ Check installation clearance. Verify there is a probe insertion clearance of 4 feet from the pipe wall.

④ Install the mounting hardware. Drill a 1½" through hole and weld the thread-o-let 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.

⑤ It should be convenient to apply a force of about 23 lb to remove or replace the probe under plant operating conditions.

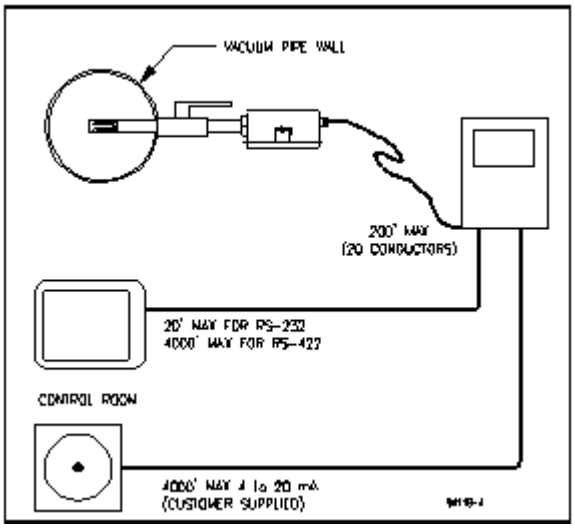


Figure 4 Maximum Cable Lengths

2.4 TRANSDUCER INSTALLATION

① Check proper installation direction. The transducer has a directional arrow on the tag and/or etched into a metal part. Before installing the unit, note proper flow direction. This is important to instrument operation.

② Check serial number. If more than one *RheoVac* unit has been purchased, make sure the complete serial number of the transducer matches the complete serial number of the separate electronics unit. The transducer and electronics are a matched set. Mismatched components will result in erroneous readings.

③ Verify stop clamp location (see Figure 6). A stop clamp is attached to the probe as an indication of its insertion depth. It is important this stay in place so the sensors are in the correct location and ensure the probes do not contact the opposite pipe wall. The clamp's location was determined based on your pipe diameter, as shown in SECTION 6.2, and is marked with a groove on the probe's shaft. Refer to this mark if the stop clamp is inadvertently moved.

④ Inspect the transducer probe tips. Be sure wetted surfaces are clean before installing. If cleaning is needed, use a damp cloth wetted with alcohol and wipe dry using a soft, lint-free cloth. Do not immerse probe in liquid alcohol or any other liquids.

⑤ Install the transducer. The instrument should be mounted through the pipe wall using the hot-tap assembly. The transducer installs so that the two probes are side-by-side across the gas stream. The transducer has a flow directional arrow on the transducer tag and/or marked into the fitting. When installing under vacuum, do not allow the clamp to "slam" against the seal nut upon opening the valve. Grasp the transducer shaft firmly before opening the ball valve. Allow the transducer to slide through the valve by controlling the amount of grip on its shaft. Special installation instructions, if any, will be noted in SECTION 6.

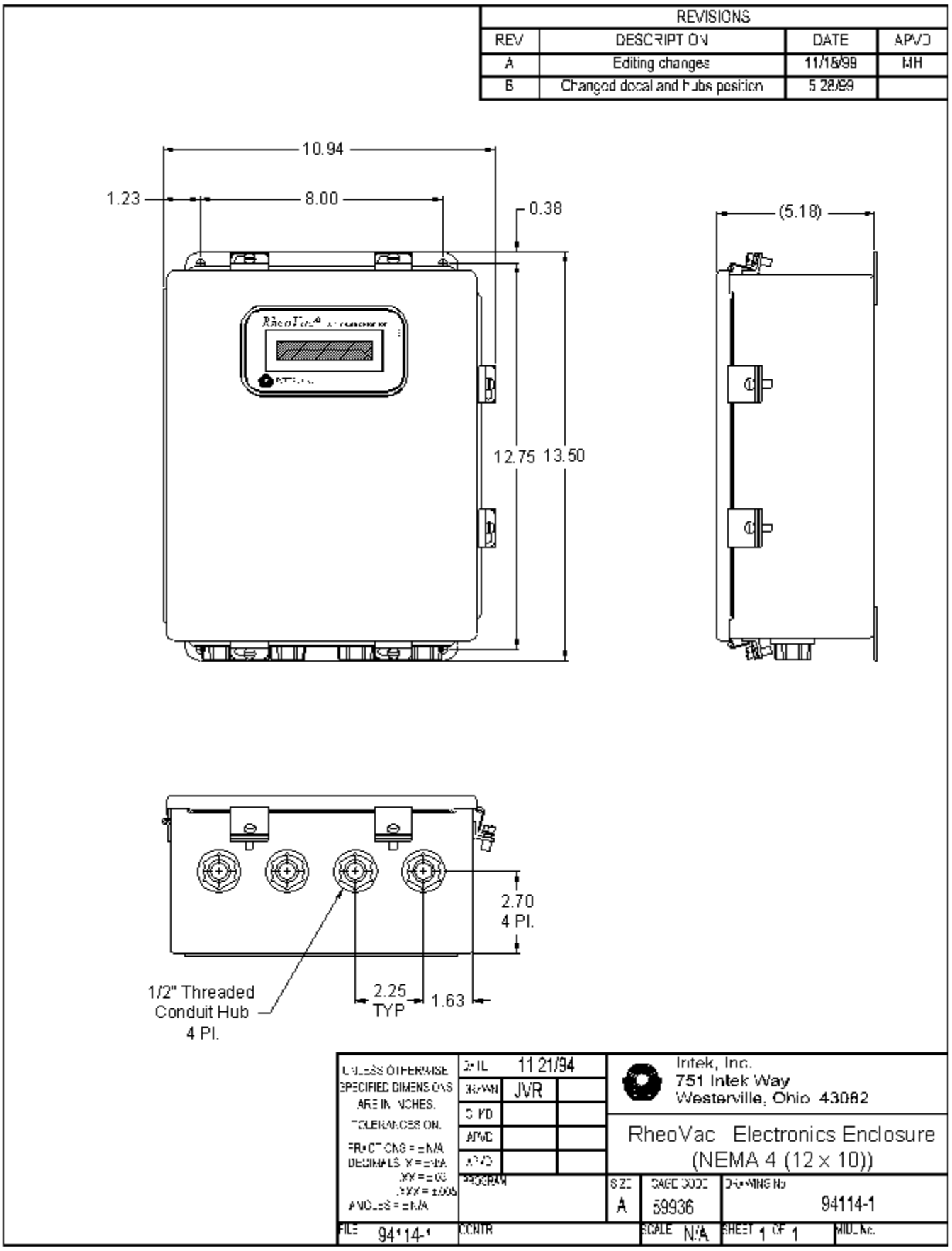


Figure 5 *RheoVac* Electronics Enclosure

2.5 ELECTRICAL CONNECTIONS

!! !! **WARNING:** Read the entire contents of this section before powering up the unit. Improper hookup may result in damage to this instrument or the interfacing equipment.

① Verify/configure the input power. The input power requirement is listed on the tag on the electronics enclosure. Be sure the input power source to be used is properly selected in the unit. Input power can be either 115 Vac or 230 Vac single phase, 50-60 Hz. The power configuration may be changed in the field. Using Figure 7, locate the power select switch on the lower printed wiring board and slide the power select switch to either the 115V or the 230V position. **Do not apply power to the instrument until all other connections and optional selections have been made.**

!! **CAUTION**: The Table 1 output signals, both – and +, are isolated from the transducer and power ground. However, the outputs are not isolated from each other; i.e. the 4-20 mA, RS232/422, and status outputs are all common to each other. All of the 4-20 mA receiver channels must have independently isolated inputs.

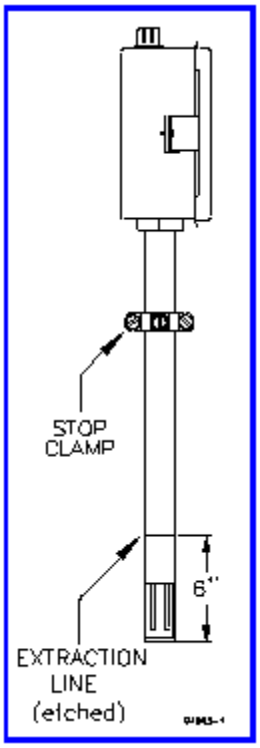


Figure 6. Transducer Stop Clamp

② Check the serial communication setup. If a distance of greater than twenty feet is needed for the serial communications, RS-422 should be used instead of RS-232 (See Figure 4). Inspect the header pin shunt (Figure 8) at JP14 (upper board) for the proper communication type. Consult Intek if the jumper is not configured correctly.

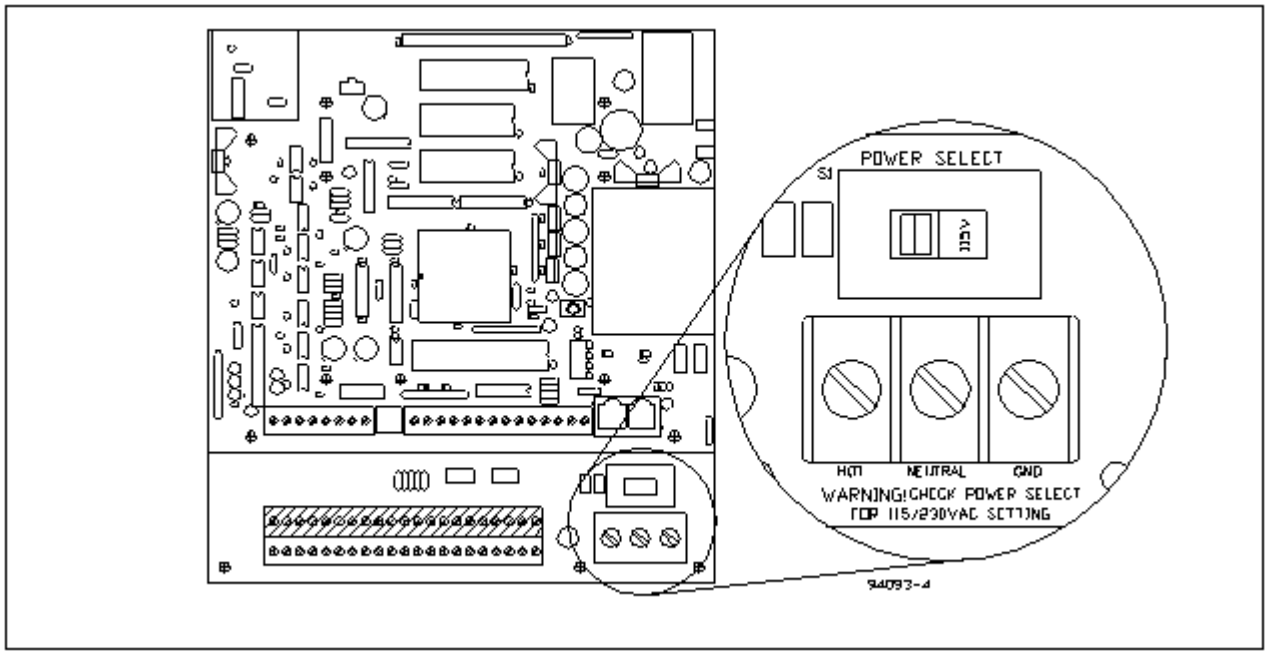


Figure 7 Input Power Select Switch

TABLE I. Ten 4-20 mA Wire Terminal Assignment

OUTPUT VARIABLE DESCRIPTION	CONFIGURATION PIN ASSIGNMENT			
	Active 4-20 mA		Passive 4-20 mA	
	–	+	–	+
ACTUAL VOLUME FLOW [ACFM]	A	B	B	A
TOTAL MASS FLOW [lbs/hr]	C	D	D	C
WATER VAPOR MASS FLOW [lbs/hr]	E	F	F	E
RheoVac PRESSURE ["Hg]	G	H	H	G
WATER VAPOR SPECIFIC VOLUME [cu. ft/lb]	I	J	J	I
WATER to AIR MASS RATIO	K	L	L	K
RELATIVE SATURATION [%]	M	N	N	M
PARTIAL PRESSURE, WATER ["Hg]	O	P	P	O
AIR IN-LEAK [SCFM]	Q	R	R	Q
RheoVac TEMPERATURE [°F]	S	T	T	S
NOT USED	U	U	U	U

③ *RheoVac* units have ten 4-20 mA outputs. These outputs can be configured collectively for either passive or active transmitter. The units are shipped from the factory with the output jumpers in the active position; i.e. the transmitter provides the current source. Figure 8 shows the locations of the 4-20 mA select jumper, JP13 of the lower board — active position is shown.

!! **CAUTION**: changing the passive/active jumper changes the field wiring polarity and affects all ten 4-20 mA channels. See Table I for wire terminal identifications.

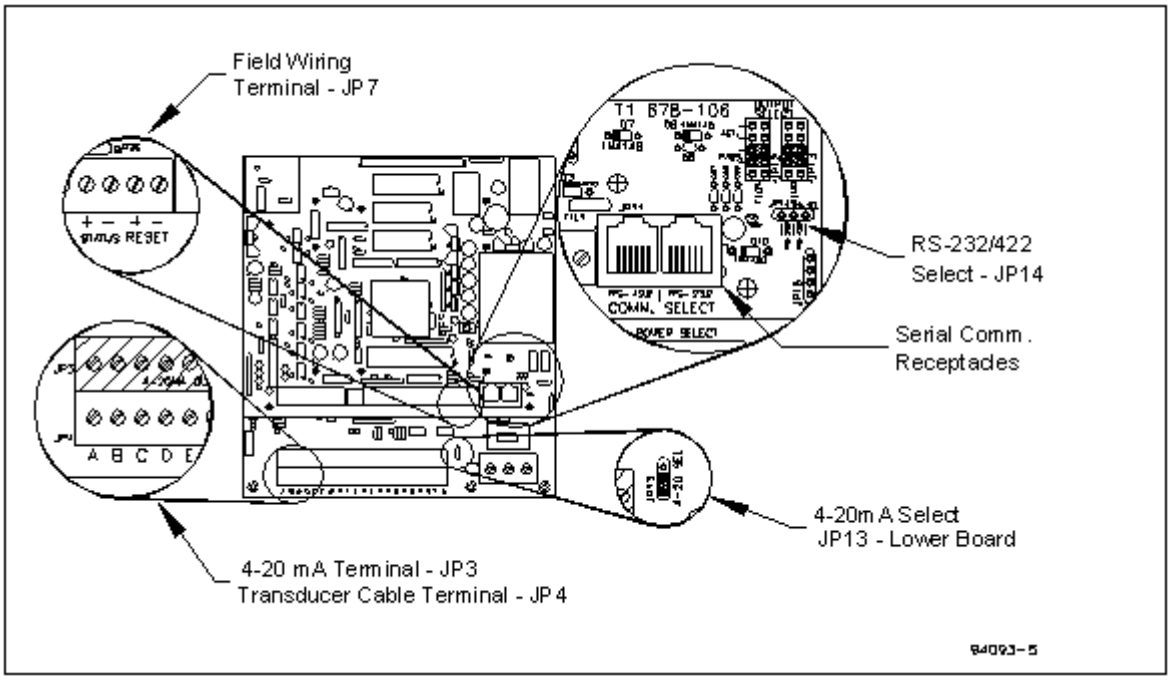
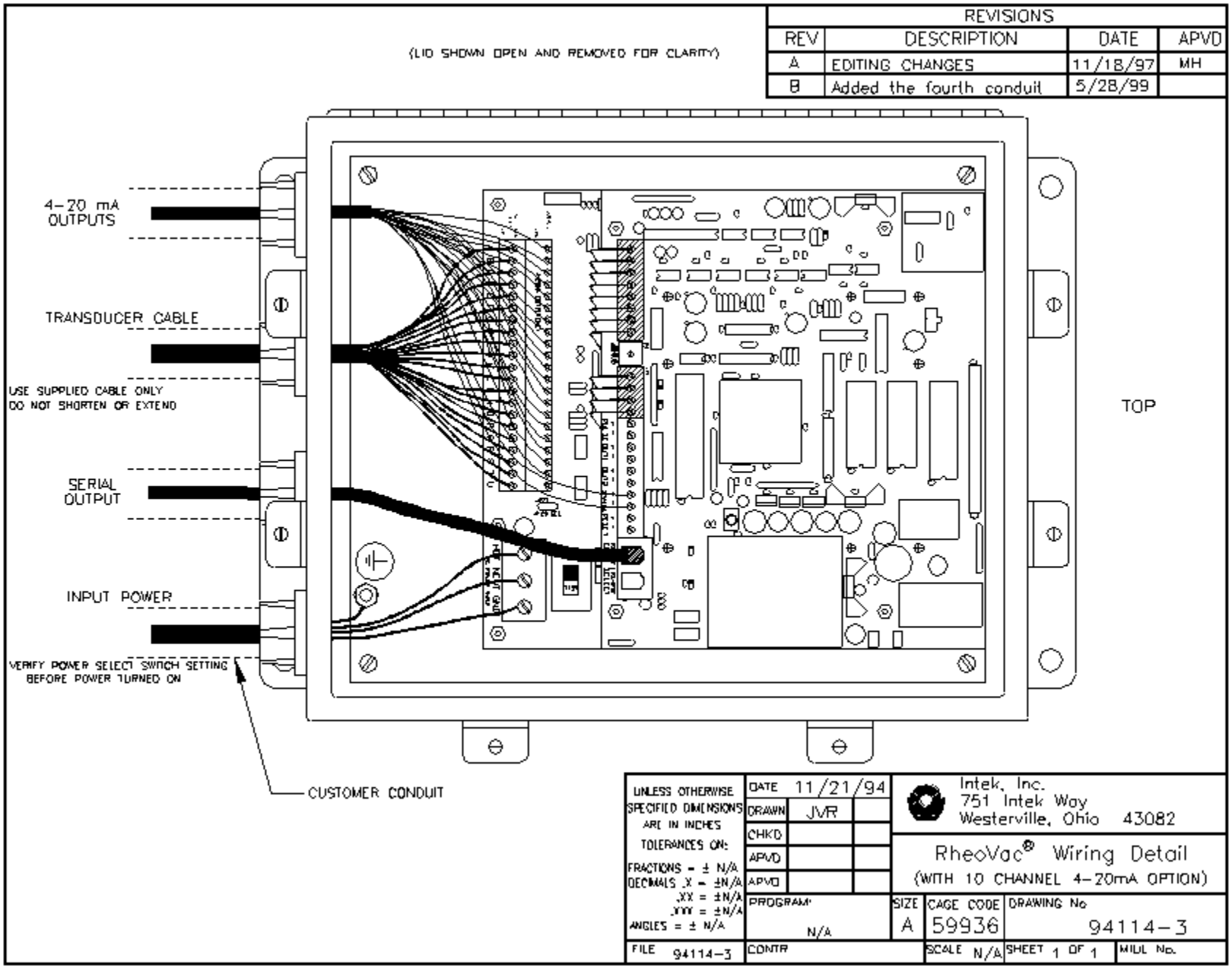


Figure 8. Output Connections and Set-up



Monitor Wiring Detail (with 10 channel 4-20 mA output)

④ Figure 9 provides the *RheoVac* wiring detail for the 10 channel 4-20 mA outputs. Table I provides the appropriate connection identification. As stated, the output signals are not isolated from each other and therefore the 4-20 mA receiver channels must be independently isolated. A typical current output circuit is shown in Figure 10. The current control circuitry works by controlling the (–) side return current through Q1 which returns current through the isolated, but circuit-common, ground (∇_1). When the 4-20mA output is configured as active, the (+) terminal is connected to a common 35 to 40Vdc supply (V_{unreg}). The circuit "A" is jumpered to the (+) output terminal and "B" is jumpered to the (–) terminal. For passive mode, the "A" is not connected, the "B" is jumpered to the (+) terminal, and the (–) terminal is connected to isolated circuit ground (∇_1).

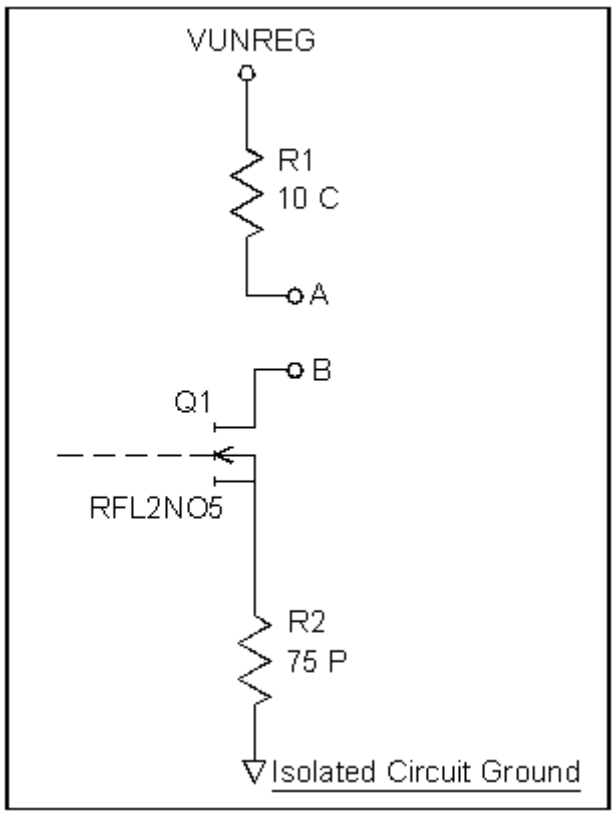


Figure 10 - 4-20mA Output Circuit

The remaining outputs - RS232/422 and status, are all (–) terminated to isolated circuit ground. A single chassis or earth ground wire should be connected to the minus of any one and only one of the receiving devices. This prevents high or noisy common-mode "floating" potentials between the isolated transmitter and grounded transducer circuits. Do not connect a ground wire to each output. Again, the 4-20mA, RS232/422 and status outputs are all common to each other and should be connected to isolated input cards.

⑤ The status output located on field wiring terminal, JP7, is a digital 0-15Vdc output. This output will go low in the event of a fault or power loss. The remaining JP7 outputs are not normally used with the *RheoVac* monitor and should be left unconnected. If a non-standard option has been ordered there will be additional notes in the SECTION 6.3 SPECIAL INSTRUCTIONS.

⑥ Mount the transmitter enclosure. Install conduit such that all seals are watertight and rigidly secure. A separate external power switch is recommended to shut the equipment off during outages. When the vacuum system is on-line, do not turn off power to the *RheoVac* monitor unless you are preparing to take the probe out of the pipe.

⑦ Choose a path for the transducer to transmitter cable conduit. Route the transducer interface cable through the conduit (See Figure 9). The cable is labeled at both ends. DO NOT CUT OR SPLICE THE CABLE, AS THIS WILL DESTROY THE LABELING AND MAY AFFECT THE INSTRUMENT CALIBRATION. Pull the cable through the conduit starting at either end; coil up the remaining length outside the transmitter or transducer enclosure, or in a cable junction box.

⑧ Pull wires through the conduit. Wire for power connection must be at least 24 gauge. After pulling the wire, pot the conduit or wires near the enclosure if there is any possibility of water from condensation or spray entering the enclosure through the conduit.

‼ **CAUTION**: The electronics are not protected against condensed liquid water inside the enclosure. Be sure conduit interfaces are dry or sealed at the instrument to prevent condensation that may be present in conduit lines from entering the enclosure.

⑨ Make wiring connections. **Power should be off at this time**. Refer to Figure 9 for *RheoVac* monitor wiring detail. Make power and transducer connections first on the lower circuit board. Next connect the 4-20 mA signal wires at JP3 and the two status output wires at JP7. There are no other terminals used on the upper board connector JP7.

‼ ‼ **WARNING**: Verify the wiring. The equipment can be permanently damaged if not wired as instructed in this manual.

Wire Color	Label	Wire Color	Label	Wire Color	Label
Drain Wire (Black)	A	Red	H	Black/Brown Stripe	O
Brown	B	Yellow	I	Green Stripe	P
Orange	C	Purple	J	Black Stripe	Q
Blue	D	Gray	K	Red Stripe	R
White	E	Brown Stripe	L	Yellow Stripe	S
Green	F	Orange Stripe	M	Purple Stripe	T
Black	G	Blue Stripe	N	Gray Stripe	U

⑩ Install serial communication interface (see Figure 11, Pg. 14). Connections are made to the serial communication receptacle with a cable with six-position RJ-11 plugs (phone type jacks) supplied as an accessory. When using the RS-232 output, plug the RJ-11 connector of the supplied cable into the *RheoVac* unit's RS-232 receptacle. Plug the other end of the RJ-11 cable into the provided RJ-11 to DB-9 adapter. The DB-9 adapter should then be plugged into any standard IBM-PC compatible RS-232 port. Table II and Figure 11 provide information on the connections.

Usually an RS-422 signal is converted to RS-232 before it is connected to a PC. The converters do not have a standardized pin assignment, so use of the RS-422 output is less straight-forward. The DB-9 pin out shown in Table II applies to an interface module, QCOM-2, made by QSI Corporation. Other modules may have different wiring. Contact the factory if you need assistance in using the RS-422 output.

Please note, the transmitter supports only one communications type at a time.

Close the lid of the enclosure. Make sure it is tight enough to make a good seal against the gasket and ensure all other enclosure openings are completely watertight.

TABLE II. 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	TBD
		8	Pulled high			8	TBD
		9	N/C			9	TBD

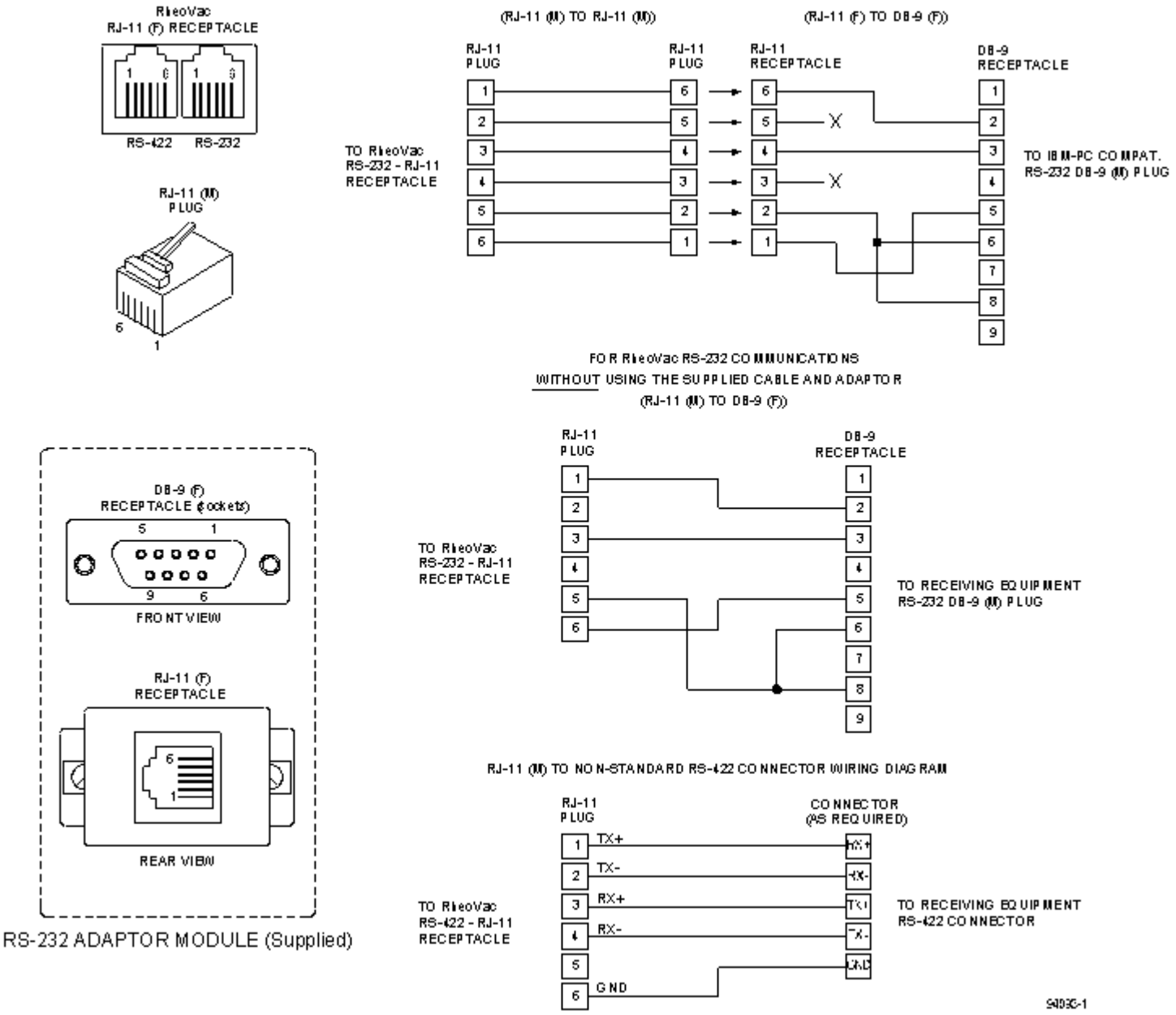
2.6 *RheoVac* SYSTEM GROUNDING

The *RheoVac* electrical system includes the *RheoVac* monitor and your data collecting inputs. In general, it is good practice to use a single point grounding scheme to terminate the system output circuit to a stable reference potential. Improper grounding may cause significant data noise, or in extreme cases, damage your equipment. To simplify this task, determine which outputs you will be using and refer to the following section for specific grounding instructions.

- RS232/422 Serial Output Only - Many PCs have non-isolated serial ports. You must determine if your serial port is isolated. With your PC (or DCS, etc.) powered and plugged into a grounded outlet measure both the Vdc and Vac between the local circuit's earth ground and pin 5 of the PC's RS232 DB-9 connector. If the voltage is not zero the circuit needs to be grounded. Connect a locally earth-grounded wire to the *RheoVac* instrument's "OUT1" (–) terminal of JP7 located next to the RS232/422 jack (see Figure 9). If the voltage reads zero, no additional grounding should be attached. Additionally, we have seen noise problems with certain laptop computers when they are connected to their external power supplies. Some of them are not fully isolated and have signal noise levels as high as 12Vac on the serial port GND pin. In this case, the circuit should also be grounded by connecting a wire to the *RheoVac*'s "OUT1" (–) terminal.

- 4-20mA Output Only - If only a single output channel is used, it may be connected directly to a non-isolated input channel without any additional grounding. Any additional output connections require isolated inputs. If all inputs are isolated, regardless of how many are used, a single channel should be grounded locally near the input card(s). In this case, connect a locally earth-grounded wire to one of the 4-20mA (–) terminals.

- Multiple Outputs - Review the special wiring configurations above. Connecting all of the used outputs to isolated input devices results in one common isolated circuit. This common circuit needs to be grounded at a single point. Choose one of the ground points listed above.



Serial Communications Interface

SECTION 3 — OPERATION

3.1 GENERAL INFORMATION

The *RheoVac* monitor is 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. This is a rare occurrence which should not happen if the transducer is properly installed, according to instructions in SECTION 2 — INSTALLATION.

3.2 SYSTEM START-UP

The *RheoVac* monitor has been designed for fast warm up following turn-on of power. When power is first turned on, no differential temperature will exist between the heated and reference probe sensors. The transmitter is programmed to apply heat to the sensor for a set period of time or until a factory set value is reached. Then the heater will return to normal. During this initialization period, the display will have the message *'*INTEK, INC.*'* on the top line and '**(614)895-0301**', the phone number of Intek, on the bottom. This message will then change to '**RheoVac**' and the unit's serial number. The bottom display line will then change to '*initializing*'. During this period the status output will be low (alarm condition) and the analog outputs should be ignored. Further, no data is being transmitted over the serial ports. The flow value will be monitored internally for stability, which will occur before the display is set to the normal reading state. After the start-up sequence, program execution is sent to the main instruction loop. It takes several seconds to execute the initialization sequence.

Upon a "cold" initial start-up of the *RheoVac* monitor, the transducer may take several minutes to give accurate air in-leak flow measurements. During this time the probe is transitioning to thermal equilibrium conditions under vacuum.

3.3 OUTPUT SIGNALS

Standard on all *RheoVac* instruments are one 2 x 20 alpha numeric LED backlit display, ten 4-20 mA analog outputs, one 0-15V digital status port, and one serial communication port. Each process variable is a linear, fully temperature and pressure compensated value on any of these readable outputs. All 4-20 mA output signals are scaled such that 4 mA represents 0% of the rated full scale value and 20 mA represents 100% of the rated full scale value. The standard full scale values and definitions of all process variables are listed in Table III.

Note: When the pressure rises above the calibrated range of 10" Hg absolute, all of the flow outputs will indicate zero. In some instruments the display will read "General Fault Mode 6" at higher pressures, such as one atmosphere. This is not a problem and the unit will read correctly under vacuum conditions. Therefore, no flow rates will be reported when the generator is off-line or during hogging until the pressure falls below 10" Hg absolute. All other variables will continue to be output normally.

Table III. Process Variable Definitions and 4-20 mA Range

PROCESS VARIABLE	4-20 mA FULL SCALE VALUE	PROCESS VARIABLE DEFINITION
ACTUAL VOLUME FLOW [ACFM]	5000	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]	10000	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 steam jet ejector capacity.
WATER VAPOR MASS FLOW [lbs/hr]	8000	The water vapor component of the flowing gas being removed from the condenser.
RheoVac PRESSURE [" Hg]	30	Absolute pressure at the *RheoVac* probe head. Should be equal to or less than turbine back pressure.
WATER VAPOR SPECIFIC VOLUME [cu. ft/lb]	10000	The inverse density of the water vapor present in the line.
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.
PARTIAL PRESSURE, WATER ["Hg]	10	The partial pressure of water vapor in the vacuum line.
AIR IN-LEAK [SCFM]	100	Actual measure of air volume flow rate passing the *RheoVac* sensor head, normalized to standard conditions (70°F, 29.9" HgA).
RheoVac TEMPERATURE [°F]	210	Temperature of the flow media at the *RheoVac* probe head.

3.4 IBM-PC SOFTWARE

IBM-PC Windows 95 compatible software has been provided. This software performs four primary functions. It allows the user to:

- access data stored inside the *RheoVac* monitor over the last 24 hours
- chart all ten process variables from the *RheoVac* serial output (transmitted by means of RS-232 or RS-422)
- archive the data into a general spreadsheet format
- change the line size stored inside the instrument for mass and volume flow calculations.

The best way to archive *RheoVac* data is with a dedicated PC or DCS serial channel. However, *RheoVac* software allows data from the last 24 hours to be downloaded to a PC file. This data is stored internally in the *RheoVac* instrument. The data format is TAB delimited and is easily imported to spread sheet programs. Column headers are included in the file and are defined in Table IV. There are two additional columns which are not shown in the table. These two columns pertain to factory calibration and diagnostics. **They are for factory use only.** For continuous archiving, a computer capable of running Windows 95 software is required. The 24-hour instrument internal record is mainly a backup for troubleshooting or for daily data collection when continuous control room recording is not available.

3.4.1 SOFTWARE INSTALLATION

System Requirements (minimum recommended):

Windows 95, 98, or NT, 32M RAM
Pentium 100MHz, SVGA 800 x 600
One (1) RS-232 serial port w/DB-9 connector

Install the software by inserting disk 1 into an IBM-PC compatible disk drive, select that drive, and click on the "Setup" icon. A folder, C:\RHEOVAC, will be created and seven files will be copied to this folder. The two executable files are: "uninst.exe" and "RVMain95.exe". The others are drivers and configuration files and must remain in the *RheoVac* folder. An Excel macro file is also included for Excel users. It quickly formats downloaded or archived data into fields with the appropriate precision and width.

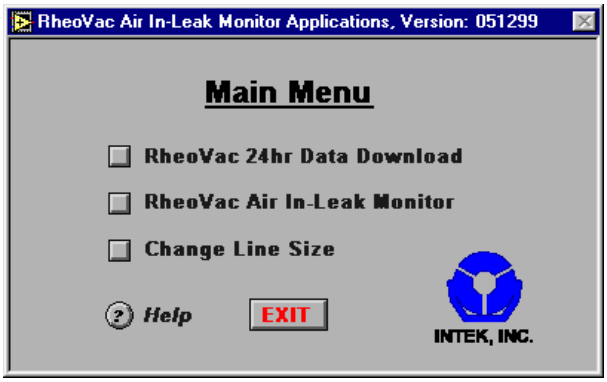
Execute the "uninst.exe" program **only** if you want to remove the entire application from your hard drive. If you want to move the application to a new drive or path, move only the folder contents to the new location.

To execute the "RVMain95.exe" application the instrument must be installed with all communication connections in place. Double click on the RVMain95 icon in the RHEOVAC folder. After several seconds a menu will appear. The first time the application is launched, you are likely to be prompted to check the system's clock setting. A real-time clock has been included on-board the *RheoVac* monitor. Therefore, the instrument has to be synchronized to your computer's clock. This is done automatically each time the software application is launched. Each download will contain a time stamp given by the *RheoVac* monitor. Make sure your host computer's clock is accurate before passing the clock setting to the instrument. A communication error message may also occur initially. When this error occurs initially, it usually means the software configuration file needs to learn which serial communication port is connected to the instrument. Select the correct port when prompted, then hit the "RETRY" button. If the error does not then go away, refer to the troubleshooting section of this manual.

3.4.2 SOFTWARE OPERATION

Execute the "RVMain95.exe" by double clicking on the RVMain95 icon in the RHEOVAC folder. Use this menu to choose from 24hr Data Download, Air In-Leak Monitor, or Change Line Size.

To select the choices from the Main Menu, left click on the button to the left of the desired option. For help feature, right click on any button or control and pick "Description..." from the pick list.



RheoVac 24hr Data Download - Selecting this choice initiates a download from the data stored in the *RheoVac* instrument. This operation takes a few minutes to complete. After the data has been transferred, you will be prompted to select a filename to store the data. The default filename is the instrument's serial number with an ".eep" file extension.

RheoVac Air In-Leak Monitor - Use this choice to plot selected data on single or dual charts. This application can also be used to acquire data continuously into your computer system. The screen shown on page 20 appears when this choice is selected. Select the rate that the *RheoVac* data will be written to disk. This number represents the time between data points saved to disk. The stored process values will be the average value of all incoming data since the last archive. After setting the archive rate, hit the "ARCHIVE TO FILE" button. This begins data collection to your hard drive. Any previously saved data in the selected file will be retained as new data is appended to the end of the older data. Each file record contains a time stamp and all ten process variables regardless of the chart configuration or group select status. The file is built in an ASCII spreadsheet tab-delimited format and can be easily imported to spreadsheet programs such as Excel.

Archiving continues to build data into the active archive file. You should maintain the file size by temporarily stopping the archive and renaming the data file based on your data management needs. Intek recommends either daily or weekly data maintenance schedules.

We encourage you to send to the factory an initial week or so of data (zipped format is preferred) via e-mail at techsupport@intekflow.com. This provides a baseline for the particular condenser 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.

For further assistance on any feature, select help by right clicking on any button or control in the application window and select "Description..." from the list.

Change Line Size - 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. Enter the new line value, then click on "Send."

3.4.3 DATA PROCESSING

TABLE IV. Column Headings for Data Downloads and Archived Data

Time Stamp (Time of day)	Actual Volume Flow (ACFM)	Total Mass Flow (lbs/hr)	Water Vapor Flow (lbs/hr)	*RheoVac* Pressure ("Hg abs)	Water Vapor Sp. Vol. (Cu. ft/lb)	Water to Air Mass Ratio (lb/lb)	Relative Saturation (%)	H_2O Partial Pressure ("Hg abs)	Air Flow In-Leak (SCFM)	Probe Temp. (°F)
0	1	2	3	4	5	6	7	8	9	10

Data may be retrieved from disk into any ASCII viewer or spreadsheet program. To do this, data archiving may need to be terminated unless you open the file as read-only. Data is stored with an appropriate number of significant digits. However, spreadsheet programs such as Excel may need you to do additional formatting to display each field to the precision you need (e.g., Excel displays the time

stamp by default in a "M/DD/YY HH:MM" format). You may prefer to reformat these cells to "M/DD/YY HH:MM:SSp/m" to display time to the nearest second in am/pm format. Once in your desired format, you may construct trend graphs using your spreadsheet or other analysis program. An Excel macro file is included to automatically format the raw downloaded or archived data.

3.5 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 values. 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 including the trailing <RETURN>. This data group is sent about once every three seconds. Table V shows the field names and number of bytes in one data stream.

TABLE V. Serial Output Data Stream

Actual Volume Flow (ACFM)	Total Mass Flow (lbs/hr)	Water Vapor Flow (lbs/hr)	*RheoVac* Pressure ("Hg abs)	Water Vapor Sp. Vol. (Cu. ft/lb)	Water to Air Mass Ratio (lb/lb)	Relative Saturation (%)	H_2O 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

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.

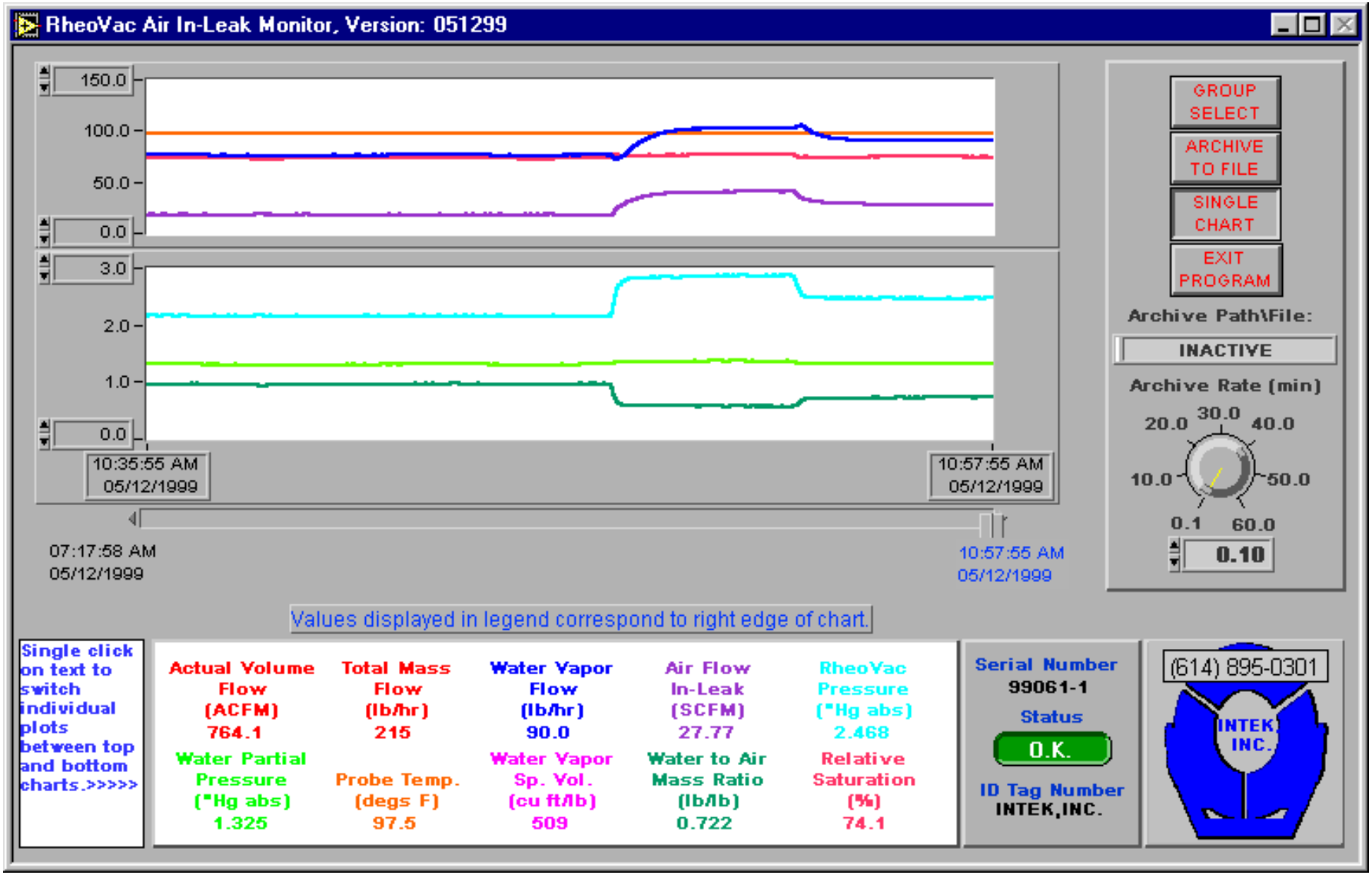


Figure 12 *RheoVac* Air In-leak Monitor IBM PC Display Menu for Plotting & Charting Data

SECTION 4 — MAINTENANCE

4.1 GENERAL MAINTENANCE

Precautions should be taken to insure proper performance of all sensors. Since the quantification technique involves signal measurements, care should be exercised to prevent build-up of dirt and/or corrosive layers on the various terminal strip connections. Periodic checks with necessary cleaning should be performed to insure clean terminals. The joints of the sensor leads should occasionally be inspected for corrosion or presence of moisture.

4.2 CALIBRATION

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

In general, calibrations should be valid over a two to five year period. 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.

4.3 SPARE PARTS

There are no normally recommended spare parts to stock. Should a spare be needed, a complete unit should be ordered and stocked.

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

- Slow blow 250mA Wickmann fuse, part number 3720250041 or equivalent, for the microprocessor printed wiring board (top board);
- Slow blow 160mA Wickmann fuse, part number 3740160041 or equivalent, for the flow meter's heater on the microprocessor printed wiring board (top board);
- Fast acting 2A Wickmann fuse, part number 3731200041 or equivalent, for the sensor interface printed wiring board (bottom board.)

4.4 TROUBLE SHOOTING

Table VI 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, take field check readings as identified in Table VII before contacting factory.

TABLE VI. Trouble Shooting Guide

OBSERVATION	PROBABLE CAUSE	ACTION
'GENERAL FAULT' 'MODE 0'	1. Shorted cable connection 2. Damaged flow sensor	1. Check for short in cable due to moisture or corrosion 2. * Contact factory
'GENERAL FAULT' 'MODE 1'	1. Improper cable hookup 2. Failed A/D circuit. Short between sensor terminals C and D of JP4 or electronics terminals 3 and 4 of JP2 3. Damaged flow sensor	1. Verify cable hookup is correct 2. Check cable connections for proper contacts or moisture & corrosion 3. * Contact factory
'GENERAL FAULT' 'MODE 2'	1. Cable contact corroded 2. Damaged flow sensor	1. Check both ends of cable for moisture or corrosion 2. * Contact factory
'GENERAL FAULT' 'MODE 3'	1. Cable cut or not connected at all	1. Check cable for contact and continuity
'GENERAL FAULT' 'MODE 4'	1. Blown heater fuse at F1 2. Damaged flow sensor	1. Check wiring and replace fuse 2. * Contact factory
'GENERAL FAULT' 'MODE 5'	1. Sensor's heater connection is open at terminal H of JP4 2. Damaged flow sensor	1. Check sensor heater for an open connection 2. * Contact factory
'GENERAL FAULT' 'MODE 6'	1. Sensor at atmospheric pressure (fault mode will disappear by the time vacuum pressures are reached). 2. Pressure sensor not connected at terminal L of JP4 3. Damaged pressure sensor	1. Restore operating vacuum condition or ignore indication 2. Check pressure sensor for an open connection 3. * Contact factory
'GENERAL FAULT' 'MODE 7'	1. Temperature is above the specified maximum (210°F) 2. Possible sensor damage	1. Record temperature and remove sensor from flow stream 2. * Contact factory
Flow output saturates high, will not respond to flow changes	1. Flow rate is not within range of calibration 2. Loose or damaged transducer cable 3. Blown heater fuse 4. Bad electronic component	1. Contact factory about re-ranging instrument 2. Fix cable / connection 3. Replace fuse 4. * Contact factory
Flow output saturates low will not respond to flow changes	1. System pressure is above 10" Hg 2. Flow rate out of range of instrument 3. Loose or damaged transducer cable 4. Bad electronic component	1. Contact factory if operation above 10" Hg is required 2. Contact factory to re-range instrument 3. Fix cable connection 4. * Contact factory

* Record voltages in Table VII (last column) before contacting the factory. Use a high input impedance digital voltmeter for these readings. All readings are to be taken from terminals A through U on JP4 (Dwg 94114-3, p. 10).

When using the *RheoVac* software on a PC, the software may give you a "Communication Error." Use the following table to determine the source of this message and appropriate action.

TABLE VI. Trouble Shooting Guide (software communication errors)

OBSERVATION	PROBABLE CAUSE	ACTION
Appears the first time the application was executed	1. Instrument not connected to the software defaulted serial port 2. Communication connections not made or instrument is not powered	1. Change serial comm port setting and hit "Retry" 2. Check connections and instrument power
Appears intermittently after application has been running normally	1. Electrical noise interfering with communications 2. Too many applications running in windows 3. Another application is conflicting with this comm port or IRQ	1. Change to RS-422 communications, re-route or shield cable 2. Close other applications until problem self corrects 3. Change to a different comm port
Completely stops working after application was been running normally	1. Instrument has stopped communicating 2. Loose or damaged communication connection	1. Check instrument power or look at instrument display for fault status 2. Check cable adapter at back of PC or at any other splices or at instrument
Cannot be made to work at all with Com3 or Com4	1. Works fine on Com1 or Com2 but does not work on other port due to other hardware conflicts such as a modem	1. Using windows Control Panel - System utility, check for IRQ or I/O hardware conflict - ADVANCED USERS ONLY
Works fine with RS-232 but does not work with RS-422	1. Converter module not wired or cabled correctly 2. Instrument jumper not set to RS-422 or jack not plugged into RS-422	1. Review communications interface section of manual. Supplied adapter is for RS-232 only. Convertor connectors may have different pinouts. 2. Move jumper or jack

If the *RheoVac* instrument is operating without fault mode indications but output readings are questionable, please send to Intek by telefax or e-mail the following plant data: turbine back pressure, hot well temperature, load, and inlet and outlet circulation water temperatures, along with a 24 hour data down load from the *RheoVac* Monitor. (See SECTION 3.4.2)

TABLE VII. Field Check Readings

JP4WIRE LABEL†		TRANSDUCER CABLE / WIRE SIGNAL DEFINITION	EXPECTED VOLTAGE [Vdc]	*RECORDED VOLTAGE [Vdc]
+	–			
B	A	Flow sensor common voltage sense	< 1.0V	
C	A	Flow sensor current return	0.000V	
D	F	Flow sensor heated RTD voltage sense	Range: 5 to 40mV	
E	B	Flow sensor heated RTD current source	Range: .2 to .4V	
F	B	Flow sensor reference RTD voltage sense	Range: .2 to .4V	
G	B	Flow sensor reference RTD current source	Range: .2 to .4V	
H	B	Flow sensor heater	<10V	
I	Q	Relative saturation sensor voltage source	Range: 10 to 14V	
J	K	Relative saturation sensor RTD differential voltage sense (+)	Range: 1.0 to 1.4V	
K	Q	Relative saturation sensor RTD offset voltage sense	Range: 0 to –2V	
L	M	Pressure sensor differential voltage sense (+)	Range: 0 to 100mV	
M	K	Pressure sensor offset voltage sense	Range: 1.5 to 2.5V	
N	Q	Relative saturation sensor voltage (+)	Range: .5 to 5.5V	
O	K	Pressure sensor current source	Range: 3.5 to 4.5V	
P	K	Relative saturation RTD current source	Range: 1.0 to 1.4V	
R	Q	Relative saturation heater supply	Range: –2 to –4V	
S	Q	Relative saturation heater return	Range: –.7 to +.05V	
T	K	Pressure sensor port heater supply	Range: –18 to –24V	
U	Q	Pressure sensor port heater return	< .1V	

*Complete this table and fax it to the factory (See SECTION 5 — CUSTOMER SERVICE).
†Connect + lead of volt meter to + column; Connect – lead of volt meter to – column.

SECTION 5 — CUSTOMER SERVICE

Intek's corporate philosophy is to help solve our customer's difficult flow measurement problems. When you purchase a *RheoVac* monitor you also receive Intek's outstanding 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 or techsupport@Intekflow.com. Our customer service staff will provide assistance promptly.

5.1 QUESTION 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 TROUBLE SHOOTING

If you have reviewed SECTION 4.4 TROUBLE SHOOTING and have questions, please call our experienced engineers for assistance. In many cases we can solve a problem over the phone by analysis of the data taken on TROUBLE SHOOTING, Table VII. Please record as much of the data as possible prior to calling.

5.3 FACTORY AND FIELD SERVICE

If you request field service, Intek has experienced engineers available to meet your needs. The *RheoVac* monitor is complex and most repairs or recalibrations will require returning the instrument to the factory. 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.

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

5.4 QUESTIONS ON NEW EQUIPMENT

For a new *RheoVac* Monitor application or any liquid or gas flow measurement need, contact the Intek technical sales department at the above phone/fax numbers. Our staff will be pleased to answer all questions and provide quotations.

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
☐ Other _____

Input Power: ☒ 115 Vac, 50/60 Hz
☐ 230 Vac, 50/60 Hz (switch)

Calibrated Ranges: Air In-Leak: ___0___ to __100__ SCFM (4-20 mA)

Outputs Ordered:
Analog: ☒ 10 outputs, Standard (See Table I)

Digital: ☐ RS-232 ☐ RS-422

Calibrated for customer line size of _____ inches, schedule _____

6.3 SPECIAL INSTRUCTIONS