Kurt J. Lesker
Company

Series 979 Atmosphere to Vacuum Transducer

Operation and Maintenance Manual

Kurt J. Lesker Company

Series 979 Atmosphere to Vacuum Transducer

Part # 100014438

Part # K____________________

Please fill in the transducer part and flange type numbers in the space above and have them readily available when calling for service or additional information.

(The part number can be found on your packing slip. Both the part number and serial number are located on the bottom side of the housing.)

For more information or literature, contact:

Kurt J. Lesker Company
1925 Route 51
Clairton, PA 15025-3681 USA

Phone: 1-412-387-9200
1-800-245-1656

Fax: 1-412-384-2745

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Package Contents

Before unpacking the 979 Atmoshpere to Vacuum (ATV) Transducer, check all surfaces of the packing material for shipping damage.

Confirm that the 979 ATV Transducer package contains these items:

- One 979 ATV unit (integrated sensor and electronics)
- One 15-pin female D-sub connector kit
- One *979 Atmosphere to Vacuum Transducer Operation and Maintenance Manual*

Inspect the components for visible evidence of damage during shipment. If anything has been damaged, notify the carrier immediately. Keep all shipping materials and packaging for claim verification.

If any items are missing from the package, call Kurt J. Lesker Customer Service at 1-412-387-9200 or 1-800-245-1656.

Do not return the product to Kurt J. Lesker unless specified to do so by Kurt J. Lesker Customer Service.

Kurt J. Lesker customer service and support:

Kurt J. Lesker Company	Telephone	1-412-387-9200
1925 Worthington Avenue	Toll-Free	1-800-245-1656 (USA only)
Clairton, PA 15025	Facsimile	1-412-384-2745
USA		

Symbols Used in this Manual

CAUTION: Risk of electrical shock.

CAUTION: Refer to the manual. Failure to heed the message could result in personal injury, serious damage to the equipment, or both.

Calls attention to important procedures, practices, or conditions.

Safety Precautions

Always disconnect the power supply before removing electronics from the Hot Cathode sensor for sensor replacement or bakeout purposes. Lethal voltages and currents may be present while the circuit is operating. Only a qualified technician should replace or adjust electronic components.

Use the proper power source. Use + 24 VDC @ 0.75 Amps.

Properly ground the transducer. The transducer should be connected to earth ground both through the vacuum flange and the back shell of the electrical connector.

Do not turn on filament power when system pressure is above $5x10^{-2}$ Torr. Hot Cathode sensor damage will result.

Do not operate with explosive gas mixtures or gases that are combustible in air. The Hot Cathode sensor has a heated element and the MicroPirani uses a thin-film Nickel element that is heated to a constant temperature above ambient. Either of these could ignite explosive gas mixtures.

Do not substitute parts or modify instrument. Do not install substitute parts or perform any unauthorized modification to the instrument. Return the instrument to an Kurt J. Lesker Calibration and Service Center for service and repair to ensure that all of the safety features are maintained.

Allow only qualified technicians to service the transducer. Users should not remove covers, casing, or plug-in components. Injury may result. A qualified technician must perform any part replacement or internal adjustments.

Keep the unit free of contaminants. Do not allow contamination of any kind to enter the unit before or during use. Contaminants such as dust, dirt, lint, glass chips, and metal chips may permanently damage the unit.

General Specifications

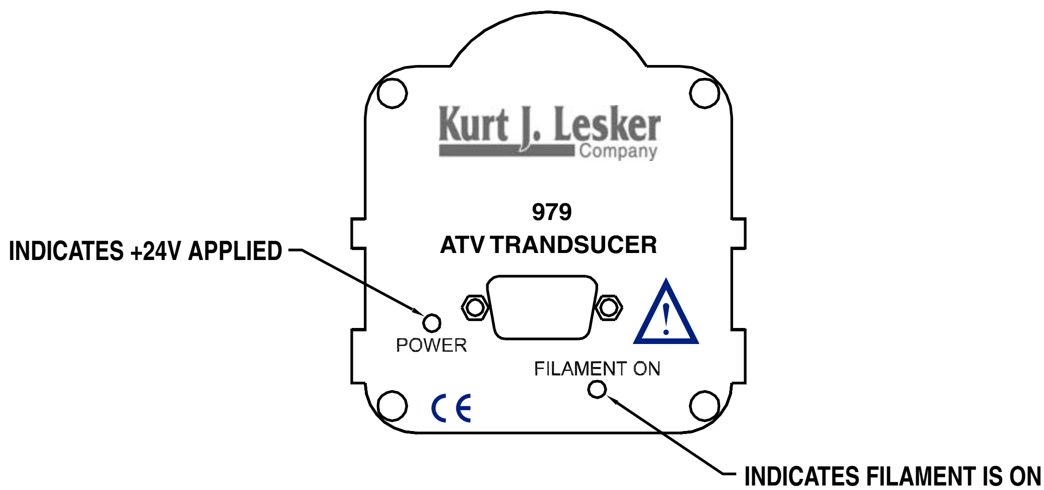
Measuring range	5x10^{-10} to atmosphere
Set point range	5x10^{-10} to 100 Torr
Analog out	1 to 9 VDC
Maximum pressure	1000 Torr
Repeatability (Typical)	1x10^{-9} to 10^{-3} Torr +/- 5% of reading 10^{-3} to 100 Torr +/- 2% of reading 100 to atm +/- 10% of reading
Accuracy (Typical)	10^{-9} to 10^{-3} Torr +/- 20% of reading 10^{-3} to 100 Torr +/- 5% of reading 100 to atm +/- 25% of reading
Supply voltage	24 VDC
Power consumption	10 Watts
Relay contact rating	1A @ 30 VAC/VDC resistive load
Materials exposed to vacuum	304 stainless steel, Silicon, SiO_2, SiN_4, gold, Ultem® 1000, Viton®, glass, tungsten, platinum clad molybdenum, yttria coated iridium
Housing material	304 stainless steel
Internal volume	0.6 cm^3
Operating temperature	0 to 40^{o}C
Bakeout temperature (off, with Hot Cathode electronics removed)	100^{o}C
Installation orientation	Any
CE certification	EN-61326-1, EN-61010-1
Vacuum connections	1” OD tube, mini CF, 2.75” CF, NW16 KF, NW25 KF, NW40 KF
Dimensions (with 1” OD tube)	2.9” x 3.1” x 4.4” (74 x 79.6 x 112 mm)
Weight (with KF 25)	0.92 lbs. (0.42 Kg)

Feature and Control Locations

All user access is through the 15-pin D-sub connector. See the **RS-485 Command Set** section for more information.

The **POWER** LED indicates when power is applied to the 979 ATV Transducer. The **FILAMENT ON** LED indicates when power is applied to the transducer filament. The **FILAMENT ON** light can also be used in conjunction with the **Test RS485 – TST** command (described in the **RS485 Command Set** section) to visually identify which sensor is set to a particular address. This is useful when several transducers are connected to the same system.

The figure below shows the front view of the 979 ATV Transducer.



About the 979 ATV Transducer

The 979 ATV Transducer is designed to measure vacuum chamber pressures as part of a user's designed system processes. It combines a Hot Cathode sensor to measure pressures from $5x10^{-10}$ to $3x10^{-3}$ Torr and a MicroPirani sensor to measure pressures from $1x10^{-3}$ to atmosphere. Once integrated into the vacuum system, the 979 ATV Transducer's functions are computer-controlled, requiring little manual intervention by the user. This enables the system to monitor pressure as a procedure invisible to the user, and when the desired pressure is reached, trigger the next event in the system process.

This manual describes the installation and configuration tasks necessary to set up the 979 ATV Transducer. After the device is set up, a software engineer at the user's installation would use the communications protocol described in this manual to create a software program (in, for example, Visual Basic, C, or C++) that will automatically control 979 operation.

For additional information on how the 979 ATV Transducer works, see the appendix **How the 979 ATV Transducer Works**.

Typical Applications for the 979 ATV Transducer

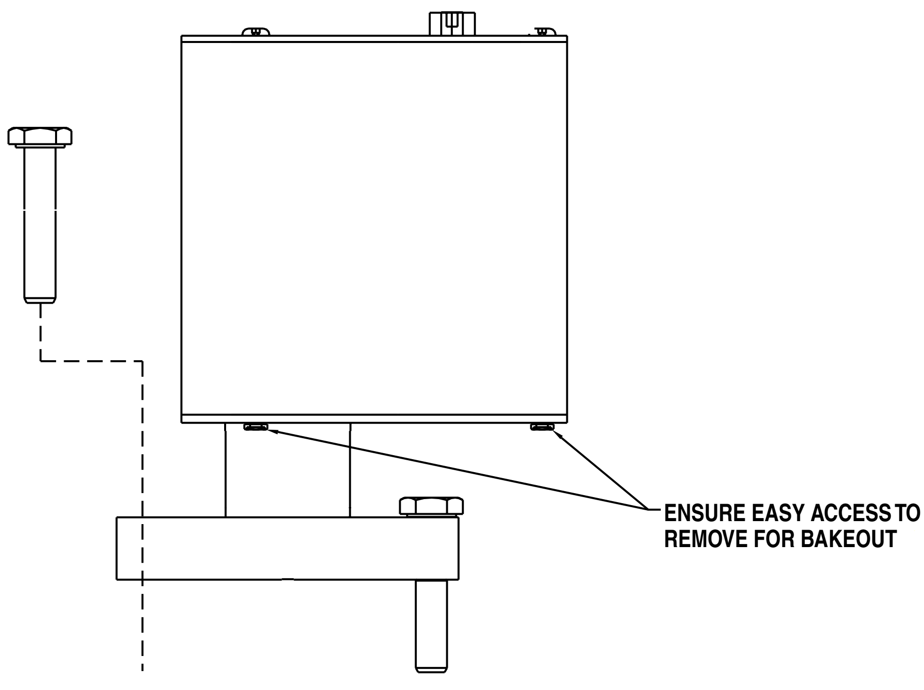
- Measure high vacuum pressure.
- Control system pressure using digital communications or analog output as input to an automatic pressure controller.
- Measure foreline and roughing pressures generated by mechanical vacuum pumps.
- Control valves and pumps to automate pump-down using relay set points.
- Sense abnormal pressure and take appropriate security measures using relay set points.
- Start or stop system processes with relay set points.
- Measure pressures of backfilling gases.

Installing the 979 ATV Transducer

ATV Transducer Installation

Location

Locate the 979 ATV Transducer where it can measure chamber pressure. Install the device away from pumps and gas sources so it will give the most representative pressure values. If the Hot Cathode sensor is going to be baked out, the four screws on the panel closest to the flange will need to be removed (see the **Bakeout** section for details). Locate the sensor to ensure easy access to those four screws.



Orientation

The 979 ATV Transducer can be installed and operated in any position without compromising accuracy.

Contamination

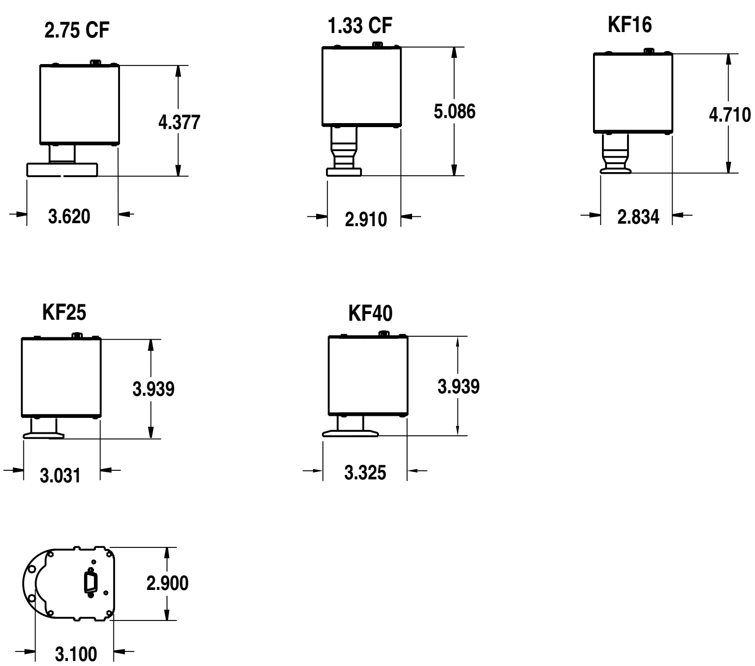
Locate and orient the 979 ATV Transducer where contamination is least likely. For example, if the 979 ATV Transducer is mounted directly above a source of evaporation, the vapor could contaminate the sensor elements and cause the calibration to shift. Whenever possible, install the 979 ATV Transducer with the vacuum port facing down to keep particulates or liquids from entering the device. To prevent inaccurate pressure measurements, shield an 979 located near an electron or ion source (e.g., near an electron beam source or in a sputtering system) and mount it away from strong magnetic fields.

Vacuum Connection

The 979 ATV Transducer is available with the following flanges:

- 2.75" CF (rotatable)
- 1.33" CF (rotatable)
- KF 16
- KF 25
- KF 40

The figure below shows the dimensions for each flange type. The top dimensions, also shown below, are valid for any flange configuration.



Electrical Connection

Use a cable with a female, 15-pin, high-density D-sub connector with strain reliefs to ensure proper electrical connection and to reduce stress on the connectors.

Ensure a low impedance electrical connection between the 979 sensor body and the grounded vacuum system to shield the sensor from external electromagnetic sources.

Input/Output Wiring

The figure and the **979 ATV Transducer Electrical Connections Table** on the following page identify the pins of the 979 connector and their functions; make a cable using this information. To comply with EN61326-1 immunity requirements, use a braided, shielded cable. Connect the braid to the metal hoods at both ends of the cable with the end for power supply connected to earth ground.

The power supply input is 24 VDC. The positive side of the power supply is connected to pin 3 and the negative side to pin 4 of the D-sub connector.

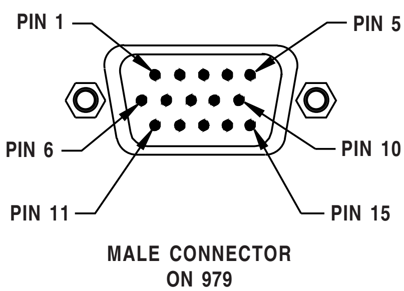
Damage may occur to the circuitry if excessive voltage is applied, polarity reversed, or if a wrong connection is made.

If using analog output (described in the **Analog Output** section), the analog output voltages are pins 5 (+) and 6 (-). Connect them to a differential input voltmeter or an analog-to-digital (A/D) converter with a differential input in a system controller.

Do not connect the negative side of the analog output (pin 6) to the negative side of the power supply input (pin 4) or to any other ground. Doing so will cause half of the power current to flow through this wire. Measurement errors in the output voltage may be seen due to the voltage drop from this current. The longer the cable, the worse the error will be.

979 ATV Transducer Electrical Connections Table

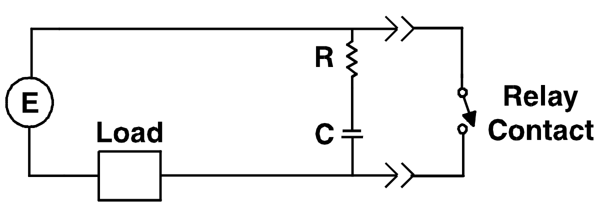
The digital communications connections are pins 1 and 2. RS-485 uses pin 1 for RS485(-) and pin 2 for RS485(+).



PIN	DESCRIPTION
1	RS485 -
2	RS485 +
3	POWER + (24V)
4	POWER -
5	ANALOG OUT +
6	ANALOG OUT -
7	RELAY 1 N.O.
8	RELAY 1 COMMON
9	RELAY 1 N. C.
10	RELAY 2 N. C.
11	RELAY 2 COMMON
12	RELAY 2 N. O.
13	RELAY 3 N. C.
14	RELAY 3 COMMON
15	RELAY 3 N. O.

Relay Inductive Loads and Arc Suppression

If using the set point relay to switch inductive loads (e.g., solenoids, relays, transformers, etc.), the arcing of the relay contacts might interfere with 979 operation and reduce relay contact life. Therefore, an arc suppression network, shown schematically below, is recommended.



The values of the capacitance C and the resistance R can be calculated by the following equations:

$C = I^2/(1 \times 10^7)$

$R = E/ I^a$

where:

C is in farads
R is in ohms
I is DC or Ac_{peak} load current in amperes
E is DC or Ac_{peak} source voltage in volts
$a = 1 + (50/ E)$
Note that $R_{min} = 0.5\ \Omega$ and $C_{min} = 1.0 \times 10\text{-}9$ F

☞ **Pressure reading gas dependence: The MicroPirani is based on measurement of thermal conductivity; therefore, the MicroPirani readout depends on the gas type and concentration. The MicroPirani is calibrated for Nitrogen gas, and will read a higher pressure when exposed to atmospheric air. The Hot Cathode sensor is based on measurement of gas ionization; therefore, the Hot Cathode readout also depends on the gas type and concentration.**

Operation

The 979 ATV Transducer operation parameters are preset at the factory. The table below shows the factory default settings. Use the commands described on the following pages to change parameter settings as necessary. The user interface to the 979 ATV Transducer is through RS-485 serial communications.

979 ATV Transducer Factory Defaults Table

Setting	Default
Active Filament	1
Address	253
Baud Rate	9600
Degas Power	Off
Emission Current	Auto
Enable Control Set Point	On
Enable Set Point 1, 2, 3	Off
Filament Power	Off
Gas Correction	1
Gas Type Calibration	Nitrogen
Hysteresis 1, 2, 3	1.10E0 Torr
Set Point Value 1, 2, 3	1.00E0 Torr
Set Point Direction 1, 2, 3	Below
Protect Set Point	1.0E-2 Torr
Unit	Torr
Analog Output	DAC1
485 Test	OFF

RS-485 Protocol

The 979 supports 2400, 4800, 9600, and 19200 baud rates (factory default: 9600). The data format is 8 data bits, no parity, and one stop bit.

Standard Addresses

Valid addresses are 3 digits, 001 to 253 (factory default: 253).

Universal Addresses

The 979 receives and responds to commands sent to address 254. For example, use 254 to communicate with a device if its address is unknown. The 979 receives and acts upon commands sent to address 255, but does not respond; use 255 to broadcast messages to multiple devices attached to the same system. For example, use 255 to change the baud rate for all devices.

Query and Command Syntax

Queries return current parameter settings; commands change the parameter setting according to the value the user types in the command syntax. Each query or command must begin with the attention character @ and end with the termination string ;FF.

Syntax required for a query is:
@<device address><query>?;FF.

Syntax required for a command is:
@<device address><command>!<parameter>;FF.

Examples:

Query current baud rate:	@253BR?;FF
Change baud rate to 19200:	@253BR!19200;FF

where:

@	attention character
253	<device address>
BR?	<query>? (for query syntax)
BR!19200	<command>!<parameter> (for command syntax)
;FF	terminator

Response Syntax (ACK/NAK)

The ASCII characters 'ACK' or 'NAK' preface the query or command response string. The ACK sequence signifies the message was processed successfully. The NAK sequence indicates there was an error.

The response to a query or a successful command is:
@<device address>ACK<data>;FF

The response to a message with an error is:
@<device address>NAK<NAK code>;FF

Examples:

ACK response:	@253ACK9600;FF (baud rate changed to 9600)
NAK response:	@253NAK160;FF (command had an error —possibly a typo)

The following list provides descriptions of the NAK codes that may be returned.

Error	NAK Code
Unrecognized message	160
Invalid argument	169
Value out of range	172
Command/query character invalid (! or ?)	175
Control setpoint enabled	195
Write to nonvolatile memory failed	196
Read from nonvolatile memory failed	197
Not in measure pressure mode	198
Pressure too high for degas	199

RS-485 Command Set

The query and command formats shown in this section are examples; the values may vary for the user's installation.

Set Up Commands

Active Filament – AF

The AF command returns which of the Hot Cathode sensor's two filaments is active, or selects between the sensor's two filaments. Related commands: **Filament Status – FS** and **Transducer Status – T** (**Status Commands** section); **Filament Power – FP** (**Pressure Measurement and Degas Commands** section). See the **Maintenance and Troubleshooting** section for information on filaments.

Values:	1, 2 (default: 1)
Query:	@001AF?;FF
Query Response:	@001ACK2;FF
Command:	@001AF!2;FF
Command Response:	@001ACK2;FF

☞ **If a different filament is selected while the filament is on, the filament power will turn off. If the control set point is enabled (see ENC) it will need to be disabled to turn the filament power back on. e.g. @001AF!2;FF, @001ENC!OFF;FF, @001FP!ON;FF, @001ENC!ON;FF**

Address – AD

The AD command returns or sets the 979 address. NOTE: If multiple devices are installed on the system, an address query using 254 (shown in the query example below) cannot determine the address of only one of the devices.

Values:	001 to 253 (default: 253)
Query:	@254AD?;FF
Query Response:	@001ACK001;FF
Command:	@001AD!002;FF
Command Response:	@002ACK002;FF

Baud Rate – BR

The BR command returns or sets the baud rate of the communications protocol. The 979 responds to this command at the present baud rate; however, the user will need to change the baud rate on the host to ensure future commands are sent at the same rate.

Values:	2400, 4800, 9600, 19200 (default: 9600)

Query:	@001BR?;FF
Query Response:	@001ACK9600;FF
Command:	@001BR!19200;FF
Command Response:	@001ACK19200;FF

Analog Output - DAC

The DAC command returns or sets the analog output scale: 1 is 0.5V/decade of pressure; 2 is 0.774V to 10V.

Values:	1, 2

Query:	@001DAC?;FF
Query Response:	@001ACKDAC1;FF
Command:	@001DAC!2;FF
Command Response:	@001ACKDAC2;FF

Emission Current – EC

The EC command returns or sets the sensor's emission current to 100uA or Auto range (100uA above $1x10^{-4}$ and 1mA below $1x10^{-4}$ Torr).

Values:	100UA and AUTO for commands; 100UA, 1MA AUTO, and 100UA AUTO for responses (default: AUTO).

Query:	@001EC?;FF
Query Response:	@001ACK1MA AUTO;FF
Command:	@001EC!AUTO;FF
Command Response:	@001ACK100UA AUTO;FF

Factory Default – FD

The FD command sets all 979 parameter values to the factory default settings shown in the **979 ATV Transducer Factory Defaults Table** (page 22). NOTE: The FD command overrides all parameter values the user sets; use with caution! The address and baud rate reset to 253 and 9600, respectively. The user must change the address and baud rate to these values on the host to communicate with the transducer after using the FD command.

Command:	@001FD!;FF
Command Response:	@001ACKFD;FF

RS Delay – RSD

The RSD command enables or disables a delay of up to 5 milliseconds between recieve and transmit mode.

Values:	OFF, ON (default OFF)
Query:	@001RSD?;FF
Query Response:	@001ACKOFF;FF
Command:	@001RSD!ON;FF
Command Response:	@001ACKON;FF

Test RS485 – TST

The TST command flashes the filament power LED ON and OFF, in order to visually identify the unit.

Values:	ON, OFF
Query:	@001TST?;FF
Query Response:	@001ACKOFF;FF
Command:	@001TST!ON;FF
Command Response:	@001ACKON;FF

Unit – U

The U command returns or sets the pressure unit to Torr, mBar, or Pascal. The units affect all pressure measurements, including set point values.

Values:	TORR, MBAR, PASCAL (default: TORR)
Query:	@001U?;FF
Query Response:	@001ACKTORR;FF
Command:	@001U!MBAR;FF
Command Response:	@001ACKMBAR;FF

User Tag – UT

The UT command returns or sets the user tag label to assign for 979 identification.

Values:	Up to 15 ASCII characters
Query:	@001UT?;FF
Query Response:	@001ACKCHAMBER1;FF
Command:	@001UT!CHAMBER2;FF
Command Response:	@001ACKCHAMBER2;FF

Status Commands

Device Type – DT

The DT command returns the transducer device type.

Query:	@001DT?;FF
Query Response:	@001ACKMP-HC 979;FF

Filament Status – FS

The FS command returns the operating status of the active filament. To select between the sensor's two filaments, see **Active Filament – AF** (**Set Up Commands** section). To turn the filament ON or OFF, see **Filament Power – FP** (**Pressure Measurement and Degas Commands** section).

Values: ON, OFF

Query:	@001FS?;FF
Query Response:	@001ACKON;FF

Firmware Version MicroPirani – FV

The FV command returns the MicroPirani firmware version.

Query:	@001FV?;FF
Query Response:	@001ACK1.00;FF

Firmware Version Hot Cathode – FVHC

The FVHC command returns the Hot Cathode firmware version.

Query:	@001FVHC?;FF
Query Response:	@001ACK1.00;FF

Hardware Version MicroPirani – HV

The HV command returns the MicroPirani hardware version.

Query:	@001HV?;FF
Query Response:	@001ACK1.00;FF

Hardware Version Hot Cathode – HVHC

The HVHC command returns the Hot Cathode hardware version.

Query:	@001HVHC?;FF
Query Response:	@001ACKA;FF

Model – MD

The MD command returns the 979 model number.

Query:	@001MD?;FF
Query Response:	@001ACK979;FF

Serial Number – SN

The SN command returns the 979 serial number.

Query:	@001SN?;FF
Query Response:	@001ACK000012345;FF

Time On – TIM1, TIM2

The TIM1 command returns the number of hours the transducer has been on. The TIM2 command returns the number of hours each filament on the Hot Cathode has been on, or clears the time on both filaments to allow the user to replace the sensor.

Values:	CLR
Query:	@001TIM1?;FF
Query Response:	@001ACK000000024;FF
Command:	@001TIM2!CLR;FF
Command Response:	@001ACKCLR;FF

Transducer Status – T

The T command returns the current status of the Hot Cathode. Related commands: **Active Filament – AF** (**Set Up Commands** section); **Set Point Value – SP1, SP2, SP3** and **Hysteresis Value – SH1, SH2, SH3** (**Set Point Commands** section).

Values:
F = Filament fault, filament cannot turn on
G = Hot Cathode on
O = OK, no errors to report
P = Pressure fault, system pressure above protect pressure
W = Hot Cathode is turning on; pressure reading not valid (when Hot Cathode is turned on, a few seconds elapse before pressure reading is valid).

Query:	@001T?;FF
Query Response:	@001ACKO;FF

Transducer Temperature – TEM1, TEM2

The TEM1 command returns the MicroPirani on-chip sensor temperature in °C. The TEM2 command returns the Hot Cathode on-chip sensor temperature in °C. If the temperature exceeds 70°C, the ambient temperature may be too high or the filament power is too high (nominal temperature rise is 30°C above ambient).

Query: @001TEM?;FF
Query Response: @001ACK2.10E+1;FF

Pressure Measurement and Degas Commands

Filament Power – FP

CAUTION: Never turn on filament power when system pressure is above $5x10^{-2}$ Torr! Sensor damage will result!

The FP command turns the filament either ON or OFF. To select between the sensor's two filaments, see **Active Filament – AF** (**Set Up Commands** section). To query the ON/OFF status of the filament, use the **Filament Status – FS** command, or the **Transducer Status – T** command (**Status Commands** section). NOTE: This command works only when the control set point is disabled (see **Enable Set Point – ENC** in the **Set Point Commands** section).

Values: ON, OFF (default: OFF)

Command: @001FP!ON;FF
Command Response: @001ACKON;FF

Degas Power – DG

Read the Degassing the Sensor section of this manual before using the DG command.

The DG command turns degas ON or OFF, or indicates if the Hot Cathode is in degas mode. Degas turns off automatically after 30 minutes, but can be turned off sooner. Pressure must be below $1x10^{-5}$ Torr for the DG command to work.

Values: ON, OFF (default: OFF)

Query: @001DG?;FF
Query Response: @001ACKOFF;FF
Command: @001DG!ON;FF
Command Response: @001ACKON;FF

Pressure Reading – PR1, PR2, PR3

The pressure reading command returns the measured pressure from either the MicroPirani (PR1), the Hot Cathode (PR2), or a combination of both (PR3). For pressures above $3x10^{-3}$ Torr, the PR3 reading is the same as PR1. For pressures below $1x10^{-4}$ Torr, the PR3 reading is the same as PR2.

Query:	@001PR1?;FF
Query Response:	@001ACK1.23E-2;FF

Set Point Commands

The 979 has three independent set point relays for control. The relay set point is based on the pressure reported by the **PR3** command (see the **Pressure Reading – PR1, PR2, PR3** command on the previous page).

Set Point Value – SP1, SP2, SP3

The set point value command returns or sets the set point value. The set point value is the pressure either below or above which the set point relay will be energized (i.e., N.O. and C contacts will be closed). The direction of the set point (ABOVE or BELOW) is configured using the **Set Point Direction – SD1, SD2, SD3** command (next page). The set point must be enabled for the set point command to function (see the **Enable Set Point – EN1, EN2, EN3** command).

Values:	Two- or three-digit scientific notation (default: 1.00E0 Torr)
Query:	@001SP1?;FF
Query Response:	@001ACK1.00E-2;FF
Command:	@001SP1!1.00E-3;FF
Command Response:	@001ACK1.00E-3;FF

Hysteresis Value – SH1, SH2, SH3

The hysteresis value command returns or sets the pressure value at which the set point relay will be de-energized (i.e., N.C. and C contacts will be closed). The hysteresis value should always be higher than the set point value. If the hysteresis and set point are the same value, or nearly the same value, the relay may chatter when the system pressure is near the set point.

Values:	Two- or three-digit scientific notation (default: 1.00E0 Torr)
Query:	@001SH1?;FF
Query Response:	@001ACK1.10E-2;FF
Command:	@001SH1!1.10E-3;FF
Command Response:	@001ACK1.10E-3;FF

Set Point Direction – SD1, SD2, SD3

The set point direction command returns or sets the direction of the set point relay. If the value is BELOW, then the relay will be energized below the set point value. (See **Set Point Value – SP1, SP2, SP3** and **Hysteresis Value – SH1, SH2, SH3**, above.)

Values:	BELOW, ABOVE (default: BELOW)
Query:	@001SD1?;FF
Query Response:	@001ACKBELOW;FF
Command:	@001SD1!ABOVE;FF
Command Response:	@001ACKABOVE;FF

Enable Set Point – EN1, EN2, EN3

The enable set point command returns enable status, or enables/disables the set point relay.

Values:	ON, OFF
Query:	@001EN1?;FF
Query Response:	@001ACKOFF;FF
Command:	@001EN1!ON;FF
Command Response:	@001ACKON;FF

Enable Control Set Point – ENC

The ENC command allows the MicroPirani to turn the Hot Cathode on or off. If the value is ON, decreasing pressure turns the Hot Cathode on at $1x10^{-3}$ Torr and increasing pressure turns the Hot Cathode off at $3x10^{-3}$ Torr.

Values:	ON, OFF (default: ON)
Query:	@001ENC?;FF
Query Response:	@001ACKON;FF
Command:	@001ENC!OFF;FF
Command Response:	@001ACKOFF;FF

Set Point Status – SS1, SS2, SS3

The set point status command returns the status of the set point relay.

Values:	SET, CLEAR
Query:	@001SS1?;FF
Query Response:	@001ACKCLEAR;FF

Protect Set Point – PRO

The PRO command returns or sets the pressure value at which the Hot Cathode will turn itself off to prevent sensor damage. The protect set point cannot be disabled and is valid during degas. NOTE: If the control set point is enabled, do not set the protect set point below $3x10^{-3}$ Torr.

Values:	1.0E-6 to 5.0E-2 Torr (default: 1.0E-2 Torr)

Query:	@001PRO?;FF
Query Response:	@001ACK1.0E-2;FF
Command:	@001PRO!5.0E-3;FF
Command Response:	@001ACK5.0E-3;FF

Calibration Commands

Atmospheric Calibration – ATM

The ATM command sets full scale readout for the MicroPirani. Vent the transducer to atmospheric pressure before performing atmospheric calibration.

☞ **For best results, leave the MicroPirani at the calibration pressure for at least 20 minutes before using the ATM command.**

Values:	Pressure value in scientific notation

Command:	@001ATM!7.60E+2;FF
Command Response:	@001ACK7.60E+2;FF

Vacuum Calibration – VAC

The VAC command zeroes the MicroPirani readout. Evacuate the transducer to a pressure below $8x10^{-6}$ Torr before performing vacuum calibration. NOTE: The MicroPirani performs the vacuum calibration automatically when the Hot Cathode pressure is below $4x10^{-6}$ Torr.

☞ **For best results, leave the MicroPirani at the calibration pressure for at least 20 minutes before using the VAC command.**

Command:	@001VAC!;FF
Command Response:	@001ACKVAC;FF

Gas Type Calibration – GT

The GT command sets gas type for measurement on the MicroPirani. The MicroPirani measures thermal conductivity; using the gas calibration compensates for gas errors.

Values:	NITROGEN, AIR, ARGON, HYDROGEN, HELIUM, H20 (default: NITROGEN)

Query:	@001GT?;FF
Query Response:	@001ACKAIR;FF
Command:	@001GT!NITROGEN;FF
Command Response:	@001ACKNITROGEN;FF

Gas Correction – GC

The GC command returns or sets the Hot Cathode gauge's sensitivity for use with gasses other than air or nitrogen. For example, if Argon is the system gas then the gas correction value would be 1.29. See the **Gas Correction Factor Table** for values.

Values:	0.10 to 50.1 (default: 1)

Query:	@001GC?;FF
Query Response:	@001ACK1.00;FF
Command:	@001GC!1.50;FF
Command Response:	@001ACK1.50;FF

Degassing the Sensor

Sensitivity of the Hot Cathode sensor may drift if the sensor elements become contaminated with system process gasses. This becomes more of a problem the lower the pressure being measured (i.e., ($\leq 10^{-8}$ Torr). To rid the sensor elements of the excess system process gasses, periodically degas the sensor. How frequently to run degas varies for each system installation.

The Hot Cathode uses Electron Bombardment (EB) degas to remove adsorbed gas from the sensor. Pressure can still be measured during degas, but due to the gas rapidly coming off the sensor elements, sensor pressure may be significantly higher than system pressure.

☞ **Degas is only activated if the indicated pressure is below $1x10^{-5}$ Torr.**

Set points are active during degas.

When degas is turned on, it is likely that the sensor pressure will increase to values exceeding $1x10^{-4}$ Torr. When the indicated pressure exceeds $1x10^{-4}$ Torr, degas turns off. Degas automatically turns on again when the indicated pressure drops back below $1x10^{-4}$ Torr (patent pending).

The temperature inside the Hot Cathode increases during degas; for electronic component life, keep degas time as short as possible. Degas operation automatically terminates after 30 minutes. When the sensor's indicated pressure has dropped back near pre-degas values, there is not much benefit to further degas operation; therefore, degas should be terminated.

☞ **Do not operate in degas mode more than 30 minutes every 4 hours.**

Sensitivities Relative to Nitrogen

If using a gas other than air/nitrogen in the system, then the user will need to change the gas correction factor for the Hot Cathode to provide an accurate pressure reading (see **Gas Correction – GC** in the **Set Up Commands** section). The table below shows GC values for some commonly used gasses. These correction factors are all relative to the nitrogen factor (which in the case of the Hot Cathode is 1). For example, if using Argon gas in the system, use the GC command as follows: @253GC!1.29;FF.

Gas Correction Factor Table

Gas	Symbol	Gas Correction Factor (GC)
Air		1.00
Argon	Ar	1.29
Carbon Dioxide	CO_2	1.42
Deuterium	D2	0.35
Helium	He	0.18
Hydrogen	H_2	0.46
Krypton	Kr	1.94
Neon	Ne	0.30
Nitrogen	N_2	1.00
Nitrogen Oxide	NO	1.16
Oxygen	O_2	1.01
Sulfur Hexaflouride	SF_6	2.50
Water	H_2O	1.12
Xenon	Xe	2.87

Analog Output

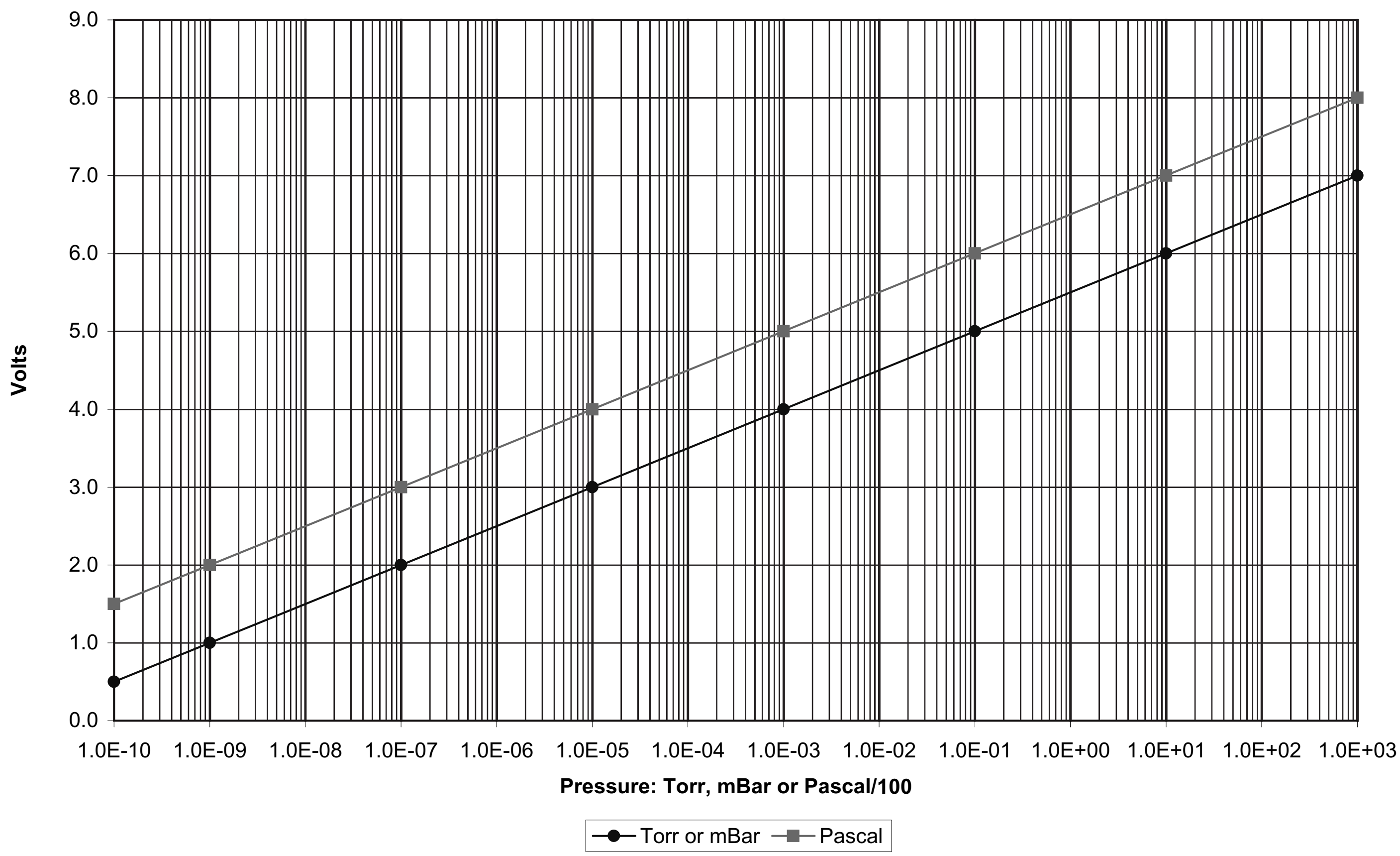
The 979 ATV Transducer analog voltage signal pins are 5 (+) and 6 (-). Connect them to a differential input. The transducer provides 2 analog output scales: DAC1 is 0.5V/decade; DAC2 is 0.774V to 10V.

☞ **Do not connect the negative side of the analog output (pin 6) to the power supply return (pin 4) or to any other ground. The voltage drop from the supply current will produce errors in the analog output voltage. The longer the cable, the worse the error will be.**

The graph below shows the correlation of DAC1 analog output to pressure.

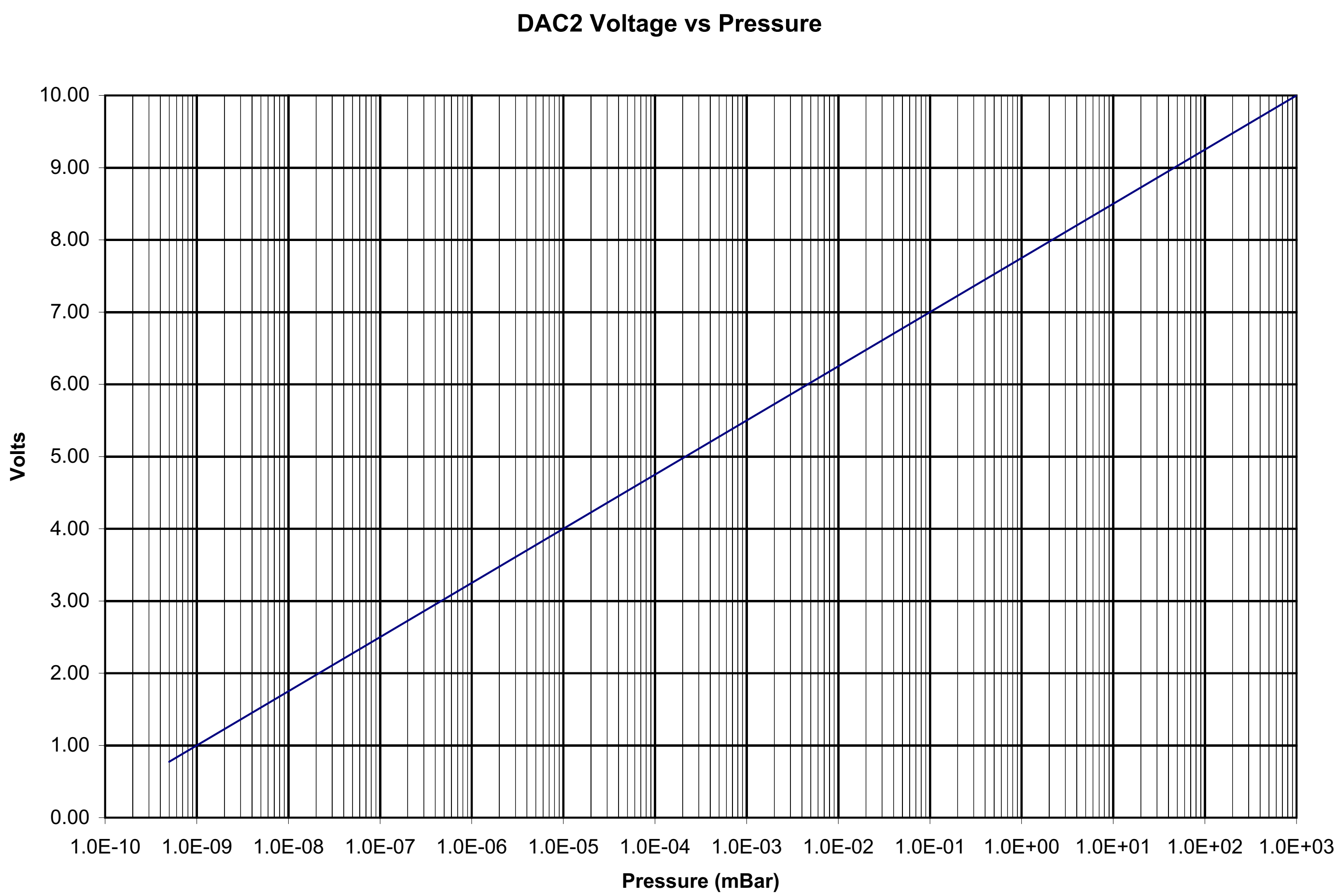
To calculate pressure from voltage: P (Torr) = $10^{(2V-11)}$

DAC1 Voltage vs Pressure



DAC1 Pressure to Voltage Table

Pressure (Torr)	Volts	Pressure (Torr)	Volts
1.0E-10	0.50	8.0E-04	3.95
2.0E-10	0.65	1.0E-03	4.00
4.0E-10	0.80	2.0E-03	4.15
8.0E-10	0.95	4.0E-03	4.30
1.0E-09	1.00	8.0E-03	4.45
2.0E-09	1.15	1.0E-02	4.50
4.0E-09	1.30	2.0E-02	4.65
8.0E-09	1.45	4.0E-02	4.80
1.0E-08	1.50	8.0E-02	4.95
2.0E-08	1.65	1.0E-01	5.00
4.0E-08	1.80	2.0E-01	5.15
8.0E-08	1.95	4.0E-01	5.30
1.0E-07	2.00	8.0E-01	5.45
2.0E-07	2.15	1.0E+00	5.50
4.0E-07	2.30	2.0E+00	5.65
8.0E-07	2.45	4.0E+00	5.80
1.0E-06	2.50	8.0E+00	5.95
2.0E-06	2.65	1.0E+01	6.00
4.0E-06	2.80	2.0E+01	6.15
8.0E-06	2.95	4.0E+01	6.30
1.0E-05	3.00	8.0E+01	6.45
2.0E-05	3.15	1.0E+02	6.50
4.0E-05	3.30	2.0E+02	6.65
8.0E-05	3.45	4.0E+02	6.80
1.0E-04	3.50	8.0E+02	6.95
2.0E-04	3.65	1.0E+03	7.00
4.0E-04	3.80		



To calculate Pressure from Voltage:

$$P=10^{\left(\frac{V-7.75}{.75}\right)+C}$$

Where: C=0 for mBar
C=2 for Pascal
C=-0.125 for Torr

DAC2 Pressure to Voltage Table

Volts	mBar	Pascal	Torr	Volts	mBar	Pascal	Torr
0.7742	5.0E-10	5.0E-08	3.7E-10	5.4273	8.0E-04	8.0E-02	6.0E-04
0.9273	8.0E-10	8.0E-08	6.0E-10	5.5000	1.0E-03	1.0E-01	7.5E-04
1.0000	1.0E-09	1.0E-07	7.5E-10	5.7258	2.0E-03	2.0E-01	1.5E-03
1.2258	2.0E-09	2.0E-07	1.5E-09	5.9515	4.0E-03	4.0E-01	3.0E-03
1.4515	4.0E-09	4.0E-07	3.0E-09	6.1773	8.0E-03	8.0E-01	6.0E-03
1.6773	8.0E-09	8.0E-07	6.0E-09	6.2500	1.0E-02	1.0E+00	7.5E-03
1.7500	1.0E-08	1.0E-06	7.5E-09	6.4758	2.0E-02	2.0E+00	1.5E-02
1.9758	2.0E-08	2.0E-06	1.5E-08	6.7015	4.0E-02	4.0E+00	3.0E-02
2.2015	4.0E-08	4.0E-06	3.0E-08	6.9273	8.0E-02	8.0E+00	6.0E-02
2.4273	8.0E-08	8.0E-06	6.0E-08	7.0000	1.0E-01	1.0E+01	7.5E-02
2.5000	1.0E-07	1.0E-05	7.5E-08	7.2258	2.0E-01	2.0E+01	1.5E-01
2.7258	2.0E-07	2.0E-05	1.5E-07	7.4515	4.0E-01	4.0E+01	3.0E-01
2.9515	4.0E-07	4.0E-05	3.0E-07	7.6773	8.0E-01	8.0E+01	6.0E-01
3.1773	8.0E-07	8.0E-05	6.0E-07	7.7500	1.0E+00	1.0E+02	7.5E-01
3.2500	1.0E-06	1.0E-04	7.5E-07	7.9758	2.0E+00	2.0E+02	1.5E+00
3.4758	2.0E-06	2.0E-04	1.5E-06	8.2015	4.0E+00	4.0E+02	3.0E+00
3.7015	4.0E-06	4.0E-04	3.0E-06	8.4273	8.0E+00	8.0E+02	6.0E+00
3.9273	8.0E-06	8.0E-04	6.0E-06	8.5000	1.0E+01	1.0E+03	7.5E+00
4.0000	1.0E-05	1.0E-03	7.5E-06	8.7258	2.0E+01	2.0E+03	1.5E+01
4.2258	2.0E-05	2.0E-03	1.5E-05	8.9515	4.0E+01	4.0E+03	3.0E+01
4.4515	4.0E-05	4.0E-03	3.0E-05	9.1773	8.0E+01	8.0E+03	6.0E+01
4.6773	8.0E-05	8.0E-03	6.0E-05	9.2500	1.0E+02	1.0E+04	7.5E+01
4.7500	1.0E-04	1.0E-02	7.5E-05	9.4758	2.0E+02	2.0E+04	1.5E+02
4.9758	2.0E-04	2.0E-02	1.5E-04	9.7015	4.0E+02	4.0E+04	3.0E+02
5.2015	4.0E-04	4.0E-02	3.0E-04	9.9273	8.0E+02	8.0E+04	6.0E+02
				10.0000	1.0E+03	1.0E+05	7.5E+02

Leak Detection

Its inherent sensitivity to gas type makes the 979 ATV Transducer useful for detecting leaks at rates greater than 10^{-4} std cc/sec of helium. It is a useful complement to a mass spectrometer leak detector, which locates smaller leaks.

Probe the suspected leak areas with a gas that is different from that of the system gas. Helium is suitable for probing a system pumping air or nitrogen.

1. Pump your vacuum system to a base pressure.
2. Slowly and methodically probe with a small amount of the tracer gas (helium).
3. Note the pressure reading.
   The pressure will rise or fall, depending upon the thermal conductivity of the probe gas relative to the system gas. The largest change in the value indicates the probe gas is nearest the leak location.
4. Repeat the test to confirm.

Bakeout/Sensor Replacement

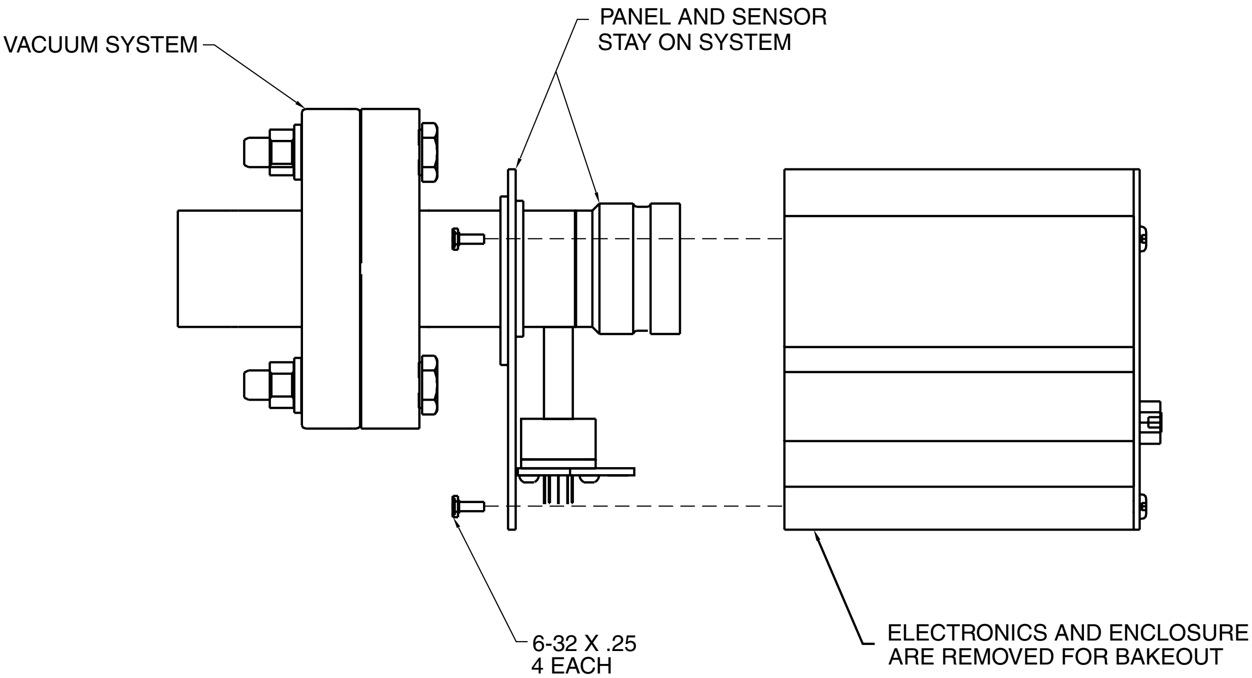
CAUTION: Disconnect the power supply before disassembly! Lethal voltages and currents may be present while the circuit is operating. Only a qualified technician should replace or adjust electronic components.

Bakeout

If building the system for the first time, or after performing routine maintenance, the system may need to be baked out to remove any water vapor.

The sensor can be baked out to 100°C (maximum) with a metal seal flange (CF) or with a Viton® seal flange (KF). To bake out the sensor, first remove the electronics. To do this:

1. Disconnect the cable from the 979.
2. Remove the four screws (as shown in the figure on the next page). The screws may be difficult to access when the sensor is attached to the vacuum system.
3. Pull the metal housing and the electronics from the sensor. The bottom panel remains attached to the sensor. Avoid removing the other four screws, two jack screws, top panel, and electronics that leave the housing attached to the sensor. The housing has labels that may come off, discolor, or burn at temperatures above 60°C. NOTE: Leave the small circuit board in place.



To re-assemble the electronics, use the disassembly steps in reverse order.

Sensor Replacement

Before disassembling the electronics for sensor replacement, use the **Time On – TIM1, TIM2** command (described in the **Status Commands** section) to clear the filament time.

To disassemble the electronics for sensor replacement, use the procedure in the **Bakeout** section.

To re-assemble the electronics, use the disassembly steps in reverse order.

For sensor part numbers, see the **Accessories and Part Replacement** section.

Maintenance and Troubleshooting

Maintenance and Troubleshooting Table

Symptom	Possible Cause/Remedy
No response to RS-485 commands	- Attention character (@) missing - Address incorrect - Termination characters (;FF) missing - Baud rate incorrect - Electrical connections missing or incorrect Note: If baud rate and electrical connections are correct, then @254;FF should give the response @253NAK;FF (the address may be different from 253).
MicroPirani vacuum pressure reading too high/too low or zero adjustment was made at the wrong pressure	Adjust zero calibration using the **Vacuum Calibration – VAC** command.
Atmospheric pressure too high/too low	Gas type is incorrect; change gas type with the **Gas Type Calibration – GT** command. Calibration is incorrect; adjust span calibration using the **Atmospheric Calibration – ATM** command.
Set point does not trip	- Set point not enabled - Set point hysteresis value not set to proper value - Set point direction is different from what the user expects - Connector miswired
No analog output voltage	- Power supply turned off - Electrical connections missing or incorrect
Power LED not on	Connector miswired, +24 V not applied
Filament light does not come on/stay on	- System pressure is above protect or control set point value - +24 V cannot supply adequate current - Sensor filament has failed (see the Sensor Test Resistance Values Table for how to test the filaments)

Symptom	Possible Cause/Remedy
Hot Cathode pressure reading incorrect	- Transducer not located properly to measure system pressure - Gas Correction factor not correct for the gas in the system - Sensor contaminated (degasing the sensor may fix this) - Leak in the vacuum system
Degas does not start	System pressure above $1x10^{-5}$ Torr when degas command is sent.

Cleaning the 979 ATV Transducer Case and Sensor Tube

The finish of the 979 ATV Transducer case is designed to resist many laboratory solvents; clean the case with water or alcohol. Take care to prevent a liquid from entering the electronic enclosure.

Roughing pump oils and other fluids condensing or decomposing on the heated filament can contaminate the sensors elements. This or other elements could cause the calibration to change, especially at low pressure.

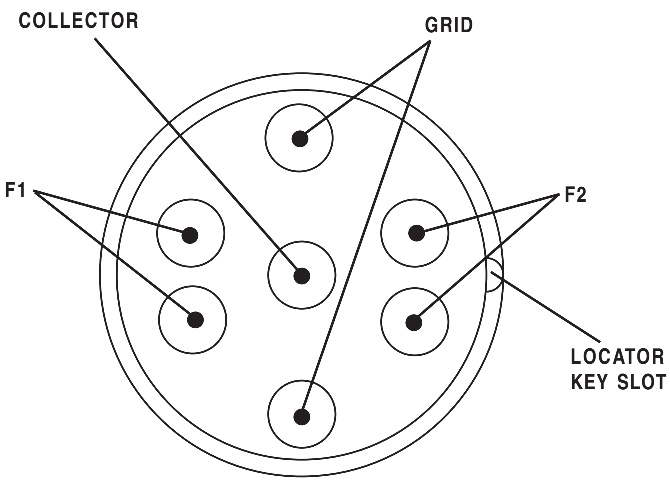
☞ **Do not attempt to clean the sensor tube. Trying to clean it may cause permanent damage to the sensor element.**

Replace the sensor if it becomes contaminated.

Sensor Test Resistance Values Table

Pin	Resistance
Filament 1 or 2 to same filament	<2 Ω
Grid to grid	<1 Ω
Grid to collector or either filament	>20M Ω
Any pin to the sensor body	>20M Ω

The figure below shows the locations of the pins.



Accessories and Part Replacement

Description	Part Number
Sensor with 2.75” CF	K97921
Sensor with 1.33” CF	K97911
Sensor with NW40 KF	K97951
Sensor with NW25 KF	K97941
Sensor with NW16 KF	K97931
Operation and Maintenance Manual	100014438

Notes:

Appendix: How the 979 ATV Transducer Works

The Series 979 ATV Transducer is a combination of two different types of pressure sensors: the Hot Cathode and the MicroPirani. The Hot Cathode sensor measures pressure indirectly from ion currents, which is proportional to gas density and pressure. The MicroPirani sensor measures pressure indirectly as a heat-loss manometer that infers the pressure of a gas by measuring thermal loss from a heated wire.

Hot Cathode Ionization Sensor

Hot cathode ionization sensors use thermionic electrons—electrons emitted from a hot filament (emission current)—to create ions in a defined volume. In their passage from the cathode through the gas volume, the electrons collide with gas atoms or molecules to form ions. The number of gas molecules ionized depends on the energy of the ionizing electrons, typically about 150 eV, and the ionization probabilities of the constituent gases. The total amount of ionization is related to the molecular concentration. The ions are accelerated to a collector electrode, where they create a current (collector current) in a circuit, which includes an electrometer. The measured current is proportional to the gas density, which in turn is directly related to the pressure, provided that other parameters like temperature are held constant. The response to pressure changes in such a device is virtually instantaneous.

Mathematically the pressure is related to ion current, or collector current, by the relationship:

$$P = I_c/(K \times I_e)$$

where:

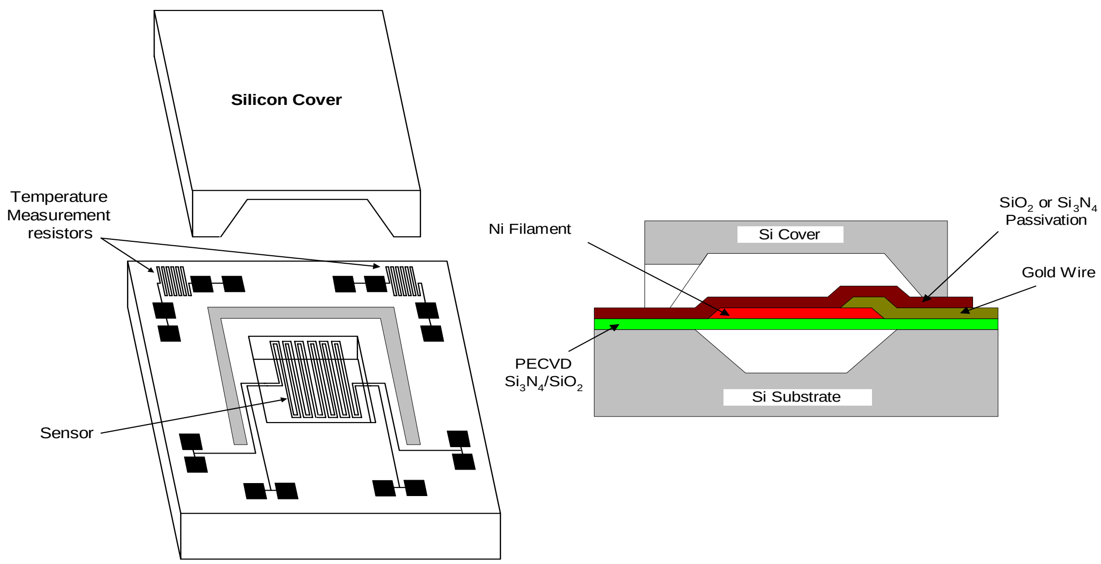
P is pressure (e.g., Torr),
Ic is collector current (Amps),
Ie is the emission current (Amps),
K is a sensitivity constant (e.g., in the case of the Hot Cathode, the sensitivity is 12/Torr).

The sensitivity (K) is dependent on gauge geometry and electrode potentials.

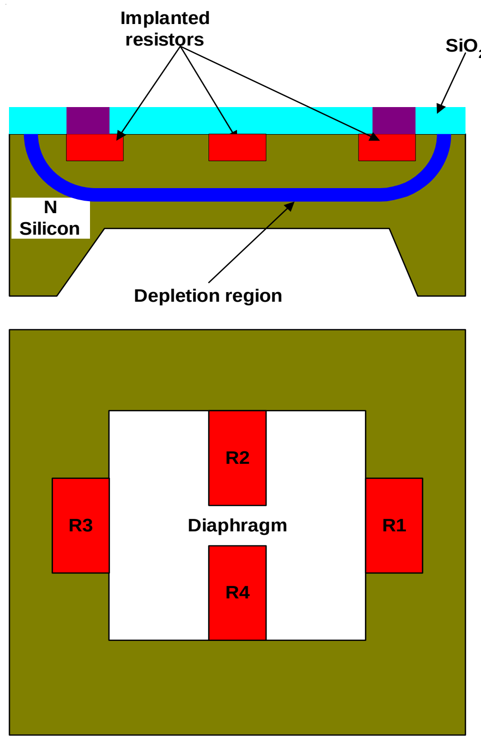
Pirani Sensor

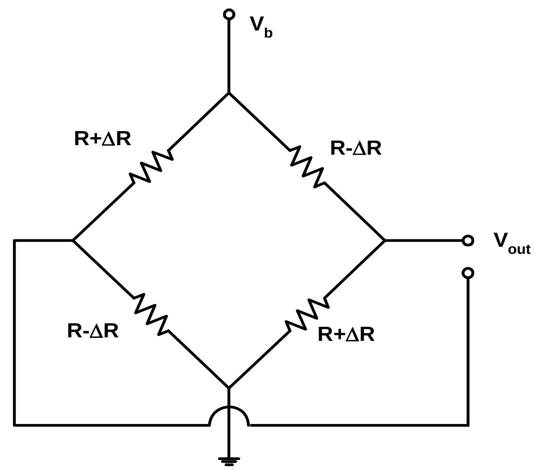
The Pirani sensor is a type of thermal conductivity sensor. It consists of a hot wire suspended from supports. This wire loses thermal energy in three ways:

- Thermal conduction through the gas, which is pressure dependent
- End loss to the supports
- Radiation to surrounding surfaces



Pirani sensors use pressure-dependent gas transport from a hot wire to measure pressure. End loss and radiation loss act as error signals and determine the low pressure limit of the sensor. Optimizing operational parameters of the wire length and diameter, thermal emissivity, thermal conductivity, and wire temperature can decrease end loss and radiation errors. A standard Pirani sensor usually has a lower reading limit of about 10^{-3} Torr, due to signal lost by end loss and radiation error.





MicroPirani Sensor

The MicroPirani sensor functions the same as a traditional Pirani sensor, but instead of a heated wire, a thin film Nickel resistive element is deposited onto a silicon substrate. This heated filament is maintained at a constant temperature above the ambient temperature of the substrate. A solid-state MicroPirani sensor has several advantages over a wire based Pirani sensor. The operational parameters are controlled and optimized to decrease the end loss and radiation errors, the integrated temperature sensors improve the temperature compensation performance, and the small geometry decreases the thermal lag time, ensuring faster response time. These improvements allow the MicroPirani sensor to operate down to 10^{-5} Torr, two decades lower than traditional Pirani sensors. The smaller distance between the heated filament and the cold substrate increases the pressure measurement range in the higher-pressure regions.