



A Fredericks Company

## MX4A Active Convection Gauge Instruction Manual



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### 1.1 Disclaimer

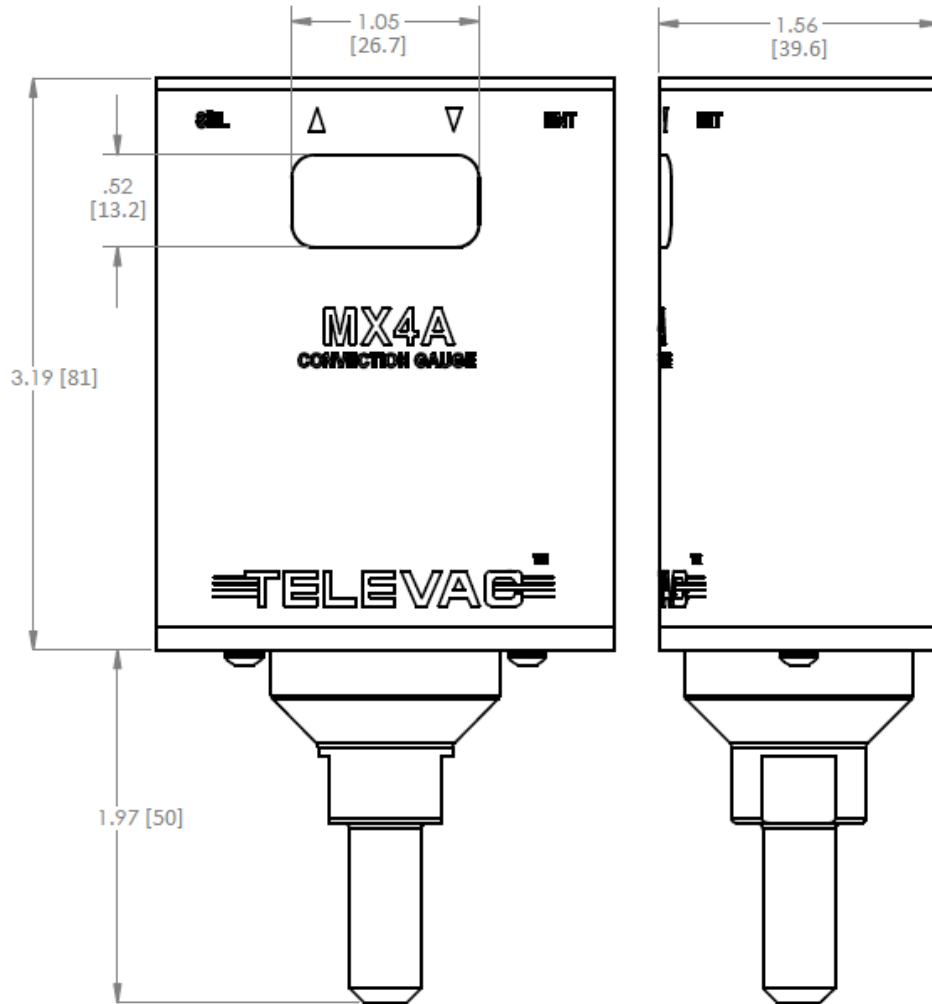
All information in this manual is subject to change without notice. The Fredericks Company assumes no responsibility for inaccuracies in product specifications or any liability arising from product use. Please contact Televac at [sales@televac.com](mailto:sales@televac.com) or call 215-947-2500 with comments or questions.

### 1.2 Description

The MX4A is a convection vacuum gauge with a range of  $1 \times 10^{-4}$  Torr to 1000 Torr. It utilizes a Televac convection vacuum sensor, part number 2-8930-0xx. It has a two color OLED display with selectable units of Torr, Millibar, and Pascal. Settings can be changed through RS-485 communications with a PC or on the unit using four capacitive touch buttons located on the top of the unit. The MX4A has 2 set points, one relay and one open collector, and a selectable analog output option. The analog output has a variety of options including three linear outputs, linear by decade, logarithmic, and non-linear.

<b>1.3 Operating Specifications</b>	
<b>Operating Range</b>	1 x 10 <sup>-4</sup> to 1000 Torr
<b>Communications</b>	RS-485
<b>Programmable Set Points</b>	2
<b>Set Point 1</b>	Open collector
<b>Set Point 2</b>	Relay
<b>Analog Output</b>	7 selectable 0 to 10 V
<b>Supply Voltage</b>	+22 to +26 V DC
<b>Maximum Power</b>	8 W
<b>Calibration Medium</b>	Dry air or nitrogen
<b>Overpressure</b>	150 PSI
<b>Digital Output Resolution</b>	2 significant digits with exponent
<b>Analog Output Resolution</b>	16 Bits
<b>Operating Temperature</b>	0° to +50° C
<b>Storage Temperature</b>	-20° to +60° C
<b>Bakeout Temperature</b>	200° C (electronics removed)
<b>Response Time</b>	≤ 1 second
<b>Accuracy</b>	
	<b>1 to 10 mTorr</b> ±1 mTorr
	<b>10 mTorr to 10 Torr</b> ±10% of reading
	<b>10 to 100 Torr</b> ±20% of reading
	<b>100 to 1000 Torr</b> ±10% of reading
	<b>Analog Output</b> ±5 mV
<b>Resolution</b>	
	<b>1 to 500 mTorr</b> 1 mTorr
	<b>500 mTorr to 5 Torr</b> 10 mTorr
	<b>5 Torr to 50 Torr</b> 100 mTorr
	<b>50 Torr to 500 Torr</b> 1 Torr
	<b>500 Torr to 1000 Torr</b> 10 Torr
<b>Display Readable Distance</b>	3 m (10 feet)

**1.4 Dimensions**



\*Dimensions are drawn with 1/8" NPT fitting installed

**1.5 Safety Information**

**START BY READING THESE IMPORTANT SAFETY INSTRUCTIONS AND NOTES**

In these instructions the word “product” refers to the MX4A and all of its approved parts and accessories.

NOTE: These instructions do not and cannot provide for every contingency that may arise in connection with the installation, operation, or maintenance of this product. Should you require further assistance, please contact Televac at the email address on the second page of this manual.

This product has been designed and tested to offer reasonably safe service provided in it’s

installed, operated and serviced in strict accordance with these safety instructions.

These safety precautions must be observed during all phases of operation, installation, and service of this product. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Televac disclaims all liability for the customer's failure to comply with these requirements.

- ✓ READ Instructions – Read all safety and operating instructions before operating the product.
- ✓ RETAIN instructions – Retain the Safety and Operating Instructions for future reference.
- ✓ HEED warnings – Adhere to all warnings on the product and in the operating instructions.
- ✓ FOLLOW instructions – Follow all operating and maintenance instructions.
- ✓ ACCESORIES – Do not use accessories not recommended in this manual as they may require a technician to restore the product to its normal operation.

The MX4A qualifies as a Safety Extra-Low Voltage (SELV) device. As such, it represents little to no hazard concerning electrical shock or burns.



Do not substitute parts or modify instrument. Because of the danger on introducing additional hazards, do not install substitute parts or perform any unauthorized modifications to the product. Return the product to Televac for service and repair to ensure that safety features are maintained. Do not use this product if it has unauthorized modifications.

The MX4A is not designed to be serviced by the operator. Any service should be done by a Televac technician. However, in the event of any attempt to service the unit, please remove the power supply to minimize the risk of harm.

The 4A sensor is user-replaceable and additional 4A sensors can be ordered from Televac by the operator. Do not attempt to use other sensors with the MX4A remote. Using another sensor may result in damage to the MX4A and voids any warranty in place.

## 2.1 Installation

Each MX4A is designed to be used in conjunction with a 4A sensor. Mount the 4A sensor in an **upright** position and as close to the area where vacuum measurement is desired. Failure to mount the 4A in a vertical position will decrease the accuracy of the measurement. Each 4A sensor has a key that only allows for the MX4A to mate with the sensor in the proper orientation. Rotate the MX4A until the correct alignment is obtained and the MX4A is able to slide onto the 4A sensor. Connect the power connector to the top of the unit and be sure to tighten the screws so that a firm connection is maintained.

Try to avoid connecting the MX4A to the vacuum chamber by long or narrow piping as this may affect the accuracy and response time of the unit. Avoid mounting the unit near a heater within the chamber

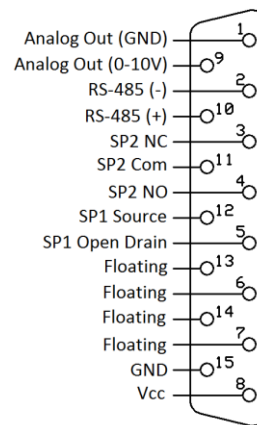
as this may affect the measurement accuracy. Excessive vibration of the unit may affect accuracy and decrease the life of the unit. Exposure to oils and other contaminants will decrease the accuracy and decrease the life of the sensor. Do not expose the unit to corrosive gases.

## 2.2 Electrical Information

Power connectors and adaptors for the use with the MX4A are available for purchase from Televac. Operators wishing to create their own adaptors should refer to the pin out of the MX4A below. Each connection labeled "Floating" has no connection and should remain so.

## Electrical Connections

Pin	Description
1	Analog Out (Ground)
2	RS-485 (-)
3	SP2 NC
4	SP2 NO
5	SP1 Open Drain
6	Floating
7	Floating
8	Supply Voltage
9	Analog Out (0 to 10 V)
10	RS-485 (+)
11	SP2 Com
12	SP1 Source
13	Floating
14	Floating
15	Ground



## 2.3 Menu Navigation

The MX4A contains many operator customizable features. Changing these features is possible through the menu or via RS485 communications. To navigate the menu simply use the buttons found on top of the MX4A. The four buttons include the SEL button, an up arrow, a down arrow, and an ENT button. Using the SEL button allows the operator to change between menu categories. Using the ENT button allows the user to enable value editing and save values in addition to toggling between options where appropriate. Using the up and down arrows allows navigation through menu options. The up and down arrow buttons are also used to edit values.

## 2.4 Menu Structure

The complete menu structure for the MX4A can be found below.

1. Measurement
2. Calibration
  - a. Vacuum
  - b. Analog Output Adjustment
  - c. Diagnostic
  - d. Default
  - e. Resolution High/Low
  - f. Atmosphere
3. Set Points
  - a. SP1H
  - b. SP1L
  - c. SP2H
  - d. SP2L
4. Units
  - a. Torr/mbar/kPa
5. Output
  - a. Analog Output
    - i. Logarithmic
    - ii. Linear by decade
    - iii. Non-linear
    - iv. Linear 4
    - v. Linear 3
    - vi. Linear 2
    - vii. Linear 1
  - b. RS-485 I/O
    - i. Address
    - ii. Baud Rate
    - iii. Stop Bits
    - iv. Parity

## 2.5 Explanation of Menu Items and Navigation

Below is a general explanation of each level of the menu structure of the MX4A.

1. Measurement

The Measurement screen contains the reading of the sensor in easy-to-read blue digits and includes units. In addition to the digital reading, the yellow bar on the Measurement screen provides an analog indication of the pressure—based on a logarithmic scale. At 1000 Torr the yellow bar should stretch across the entire screen. At 0 Torr the yellow bar will disappear, and at 1 Torr, the yellow bar will be half way across the screen.

## 2. Calibration

To reach the Calibration screen from the Measurement screen, press SEL once. Press the UP and DOWN arrows to navigate between panes under the Calibration heading.

To ensure that the operator always has the most accuracy, the MX4A includes a number of operator-usable calibration points. While the MX4A is factory calibrated, the use of the included calibration points may become necessary after extended use, contamination, etc. If accuracy is critical, it is recommended to return the sensor to TELEVAC for NIST-traceable calibration.

### a. Vacuum

The Vacuum screen is immediately accessible from the first pane of the Calibration screen. Press ENT to allow access to reading adjustment. Press UP or DOWN to adjust the reading. When the desired reading is reached, press ENT to save and lock the change.

The Vacuum calibration point allows the gauge to adjust the pressure reading at high vacuum (“zeroing”). This should be used only when the operator knows that the unit is pumping down below  $10^{-4}$  Torr and the unit reads a non-zero number. When the vacuum is below the range of MX4A measurement (preferably as low as  $10^{-5}$  Torr), adjust the unit until it blinks between .0000 and .0001.

For users calibration against a NIST calibrated standard, maximum accuracy for the MX4A can be obtained by calibrating it to .0050 Torr instead of the normal .0000 Torr reading.

### b. Analog Output Adjustment

The Analog Output Adjustment is accessible from the Calibration screen by pressing DOWN once. The adjustment is unlocked by pressing ENT. A change in the calibration value is set by using UP or DOWN. When the desired reading is reached, press ENT to save and lock the change.

The analog output accuracy for the MX4A generally agrees with the digital reading exactly. However, in extreme temperatures or in significant humidity, the agreement may change somewhat. For uses of the MX4A where the analog output accuracy is critical, an adjustment is available to ensure accuracy. When making this adjustment use a calibrated voltmeter to measure the analog output voltage when the MX4A is at a very stable pressure. Compare this voltage reading to the expected voltage. The expected voltage can be determined based on the formulae in the section of this manual entitled [Analog Output](#).

### c. Diagnostic

The Diagnostic screen is accessible from the Calibration screen by pressing DOWN twice.

The Diagnostic screen is used by Televac technicians when inspecting the MX4A for any problems. Under no circumstance does the operator need to access or consider this screen.



#### d. Default

The Default screen is accessible from the Calibration screen by pressing DOWN three times. Pressing ENT twice will trigger a reset to the factory defaults.

The Default screen resets all calibration point adjustments, set points, and RS485 setting will be restored to the default values. This feature should only be used when necessary. Warning: RESTORING TO DEFAULT SETTINGS VOIDS THE CALIBRATION!

#### e. Resolution High/Low

The Resolution screen is accessible from the Calibration screen by pressing DOWN four times. Pressing ENT unlocks the screen and pressing UP or DOWN will change the resolution. When the desired reading is reached, press ENT to save and lock the change.

The Resolution of the MX4A is set to Low by default. Under this setting the resolution is determined based on the accuracy of the gauge and will automatically adjust the resolution based on the pressure. While the MX4A always displays four digits on the Calibration screen, for operators who are looking for more resolution on the measurement Screen, the MX4A can be set to High resolution and will display four digits on the Measurement screen.

#### f. Atmosphere

The Atmosphere screen is accessible from the Calibration screen by pressing DOWN five times. Press ENT to allow access to reading adjustment. Press UP or DOWN to adjust the reading. When the desired reading is reached, press ENT to save and lock the change.

The Atmosphere calibration point allows the gauge to adjust the pressure reading at Atmosphere (760 Torr). This should be used only when the operator knows that the unit is exposed to Atmosphere or is compared to a reference gauge that is NIST calibrated and reading near 760 Torr.

For users calibration against a NIST calibrated standard, maximum accuracy for the MX4A can be achieved by adjusting the unit between 740 Torr and 780 Torr.

#### g. Mid

The Mid adjustment screen is accessible from the Calibration screen by pressing DOWN six times. Press ENT to allow access to reading adjustment. Press UP or DOWN to adjust the reading. When the desired reading is reached, press ENT to save and lock the change.

The Mid calibration point allows the gauge to adjust the pressure reading at 70 Torr. This should be used only when the operator knows that the unit is exposed is compared to a reference gauge that is NIST calibrated and reading near 70 Torr.

For users calibration against a NIST calibrated standard, maximum accuracy for the MX4A can be achieved by adjusting the unit between 65 Torr and 75 Torr.

### 3. Set Points

To reach the Set Point screen from the Measurement screen, press SEL two times. The Set Point screen contains Set Point 1 High. To change Set Point 1 Low, Set Point 2 High, or Set Point 2 Low, press the down arrow from the initial Set Point screen. When the correct set point is selected, press ENT to unlock adjustment. Use UP and DOWN to change the value. When the desired reading is reached, press ENT to save and lock the change.

The MX4A contains two set points for the convenience of the operator. The first set point controls an open collector. The second set point controls a relay.

### 4. Units

To reach the Units screen from the Measurement screen, press SEL three times. Press ENT to unlock the screen. Use UP and DOWN to navigate between units. When the desired reading is reached, press ENT to save and lock the change.

Depending on the process or the region, the desired units for the MX4A may vary. To accommodate this need, the MX4A includes a unit adjustment feature. The MX4A can be set to display the units in Torr, kPa, or mbar.

### 5. Output

To reach the Output screen from the Measurement screen, press SEL four times. Use UP and DOWN to navigate between the Analog Output and RS-485 panes. When the desired field is present, press ENT to enter the heading.

The MX4A features a number of analog outputs and RS-485 digital output and input.

#### a. Analog Output

To toggle the Analog Output, press ENT to unlock the screen. Then press UP or DOWN to set the desired output type. Press ENT to save and lock the change.

The types of Analog Output are listed below. For more information on the types of output, please see the heading in this manual labeled [Analog Output](#).

- i. Logarithmic
- ii. Linear by decade
- iii. Non-linear
- iv. Linear 4
- v. Linear 3
- vi. Linear 2
- vii. Linear 1

## b. RS-485 I/O

To make changes under the RS-485 I/O screen, press UP or DOWN to reach the desired sub-heading. Then press ENT to unlock the heading. Use UP or DOWN to change the fields. Press ENT to save and lock the change.

The following fields are listed below. Please see the sections labeled [RS-485 Communications](#) and [Changing Communications Parameters](#) for more details and a complete list of commands. Listed below are the fields with the RS-485 I/O screen.

- i. Address
- ii. Baud Rate
- iii. Stop Bits
- iv. Parity

## 2.6 Analog Output

The MX4A provides the option for outputting the vacuum reading in an analog form. Operators who wish to use PLCs to monitor processes should find this function useful. There are seven different analog output formats to choose between. The formats include Logarithmic, Linear by decade, Non-linear, Linear 4, Linear 3, Linear 2, and Linear 1.

1. Logarithmic: The Logarithmic output is the most useful and accurate output for covering the entire range of the 4A with an analog output. This format uses the formula below to convert the output voltage into a pressure measurement :

$$Pressure (Torr) = 10^{.6 \times (Voltage - 5)}$$

For example, a voltage reading of 3.075 Volts corresponds to pressure of .07 Torr.

$$10^{.6 \times (3.075 - 5)} = .07 Torr$$

2. Linear by decade: The Linear by decade output spans the entire range of the MX4A. It uses the units digit of the voltage reading to communicate the decade of the pressure reading and the units after the decimal to communicate the specific pressure using the very generalized expression below, where A, B, C, and D are digits ranging from 0-9:

$$Voltage = A.BCD \rightarrow Pressure (Torr) = 10^{(A-6)} \times BCD$$

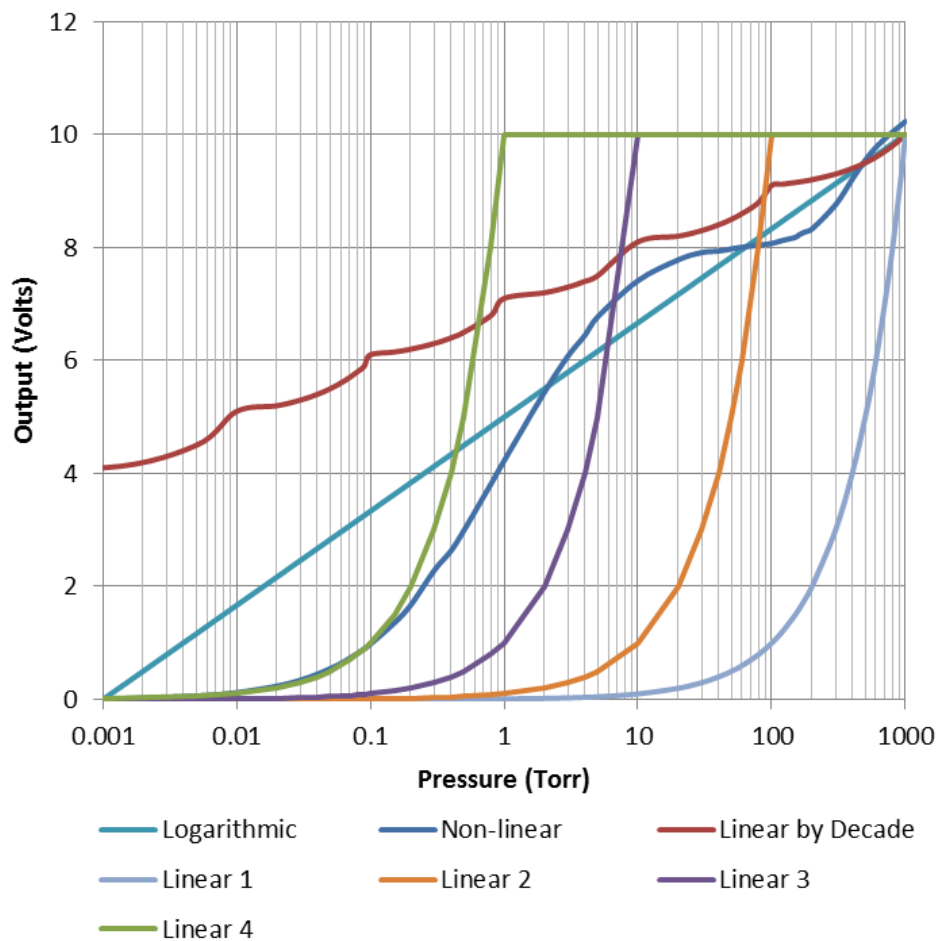
For example, a voltage reading of 8.367 Volts corresponds to a pressure of 36.7 Torr.

$$10^{(8-6)} \times .367 = 36.7 Torr$$

3. Non-linear: The Non-linear option outputs the raw signal collected by the 4A sensor. The raw signal is converted to the pressure using a many-point linearization process done by the MX4A. This feature is used for diagnostic purposes.
4. Linear 4: The Linear 4 output is one of four linear outputs that cover a select range of the MX4A with a linear scale. The scale extends from .001 to 1 Torr, with each .001 Volt of the output corresponding to .001 Torr.

5. Linear 3: The Linear 3 output is one of four linear outputs that cover a select range of the MX4A with a linear scale. The scale extends from .01 to 10 Torr, with each .001 Volt of the output corresponding to .01 Torr.
6. Linear 2: The Linear 2 output is one of four linear outputs that cover a select range of the MX4A with a linear scale. The scale extends from .1 to 100 Torr, with each .001 Volt of the output corresponding to .1 Torr.
7. Linear 1: The Linear 1 output is one of four linear outputs that cover a select range of the MX4A with a linear scale. The scale extends from .1 to 1000 Torr, with each .001 Volt of the output corresponding to .1 Torr.

**Graph of Analog Output Functions Available on the MX4A**



### RS485 Communications

This gauge communicates with the host computer through RS-485 interface. Each communication correspondence consists of a command line sent by the host computer and a response from the gauge.

To communicate with the MX4A via RS-485, the user must have an RS-485 capable device to send commands to the MX4A. Each command must be preceded by a \* and will be an S, R, or W. See the [Communications Specifications](#) heading for information on what settings are necessary to properly communicate with the MX4A.

### 3.1 Changing Communication Parameters

The communication parameters, (baud rate, address, etc.), are changed through the local menu. Please see the section in this manual entitled [Explanation of Menu Items and Navigation](#) for more information on navigating and editing within the menu. Below are provided some specifics on the RS-485 Communications of the MX4A.

#### 3.2 RS-485 Communication Specifications

<b>Interface</b>	RS-485 compatible
<b>Data Transfer Method</b>	Synchronous/half duplicate method
<b>Baud Rate</b>	1200/4800/9600/19200/38400
<b>Data Format</b>	1 start bit, 8 data bits, 0 parity bit, 1 stop bit
<b>Error Detection</b>	Parity bit
<b>Parity Bit</b>	None/even/odd
<b>Stop Bit</b>	½
<b>Transfer Distance</b>	Max 100 meters

#### 3.3 RS-485 Commands

Command	Description
<b>R1</b>	Read units
<b>R2</b>	Read SP1L and SP1H
<b>R3</b>	Read SP2L and SP2H
<b>W1</b>	Set Pressure Units
<b>W2</b>	Set SP1L,SP1H
<b>W3</b>	Set SP2L,SP2H
<b>S1</b>	Read Pressure Data
<b>RC1</b>	Read Vac. Adjustment
<b>RC2</b>	Read Atm. Adjustment
<b>RC3</b>	Read Mid Adjustment
<b>WC1</b>	Write Vac. Adjustment
<b>WC2</b>	Write Atm. Adjustment
<b>WC3</b>	Write Mid Adjustment

3.4 Sample RS-485 Commands (assume address 0)		
Command	Sample Output	Description
<b>*OR1</b>	0001	Units are in Pa
	0002	Units in Torr
	0003	Units in mBar
<b>*OR2</b>	ppsePPSE	Lower set point 1 given by ppse Upper set point 1 given by PPSE
	ppsePPSE	Lower set point 2 given by ppse Upper set point 2 given by PPSE
<b>*OW10001</b>	0001	Units are in Pa
	0002	Units are in Torr
	0003	Units are in mbar
<b>*OW2ppsePPSE</b>	ppsePPSE	Assign set point 1 lower to ppse and Assign set point 1 upper to PPSE
<b>*OW3 ppsePPSE</b>	ppsePPSE	Assign set point 2 lower to ppse and Assign set point 2 upper to PPSE
<b>*OS1</b>	ppse	Vacuum reading is ppse
<b>*ORC1</b>	Baaa	Read Vac. Adjustment
<b>*ORC2</b>	Baaa	Read Atm. Adjustment
<b>*ORC3</b>	Baaa	Read Mid Adjustment
<b>*ORW1Baaa</b>	BaaaPPSE	Vac. Adjustment is Baaa, Vacuum reading is PPSE
<b>*ORW2Baaa</b>	BaaaPPSE	Atm. Adjustment is Baaa, Vacuum reading is PPSE
<b>*ORW3Baaa</b>	BaaaPPSE	Mid Adjustment is Baaa, Vacuum reading is PPSE

Understanding ppse, PPSE, and Baaa: Both ppse and PPSE are simply generic pressure readings in whichever units are selected.	
Letters	Description
<b>pp</b>	Mantissa of a pressure
<b>s</b>	Sign of exponent (0 is negative and 1 is positive)
<b>e</b>	Exponent of pressure
<b>PP</b>	Mantissa of a pressure
<b>S</b>	Sign of exponent (0 is negative and 1 is positive)
<b>E</b>	Exponent of pressure
<b>B</b>	Sign of exponent (0 is negative and 1 is positive)
<b>aaa</b>	Number between 000 and 499

Examples for ppse, PPSE, and Baaa	
Letters	Description
<b>ppse = 2412</b>	Pressure = $2.4 * 10^2$
<b>ppse = 8703</b>	Pressure = $8.7 * 10^{-3}$
<b>PPSE = 3402</b>	Pressure = $3.4 * 10^{-2}$
<b>PPSE = 5211</b>	Pressure = $5.2 * 10^1$
<b>Baaa = 0249</b>	Adjustment = -249
<b>Baaa = 1382</b>	Adjustment = 382

3.5 Error Code Explanations	
<b>0N0001</b>	Command Error; undefined character (other than R,W, and S) in CMD line
<b>0N0002</b>	Undefined command after R,W, or S)