



## Bullseye Piezo User Manual



**Software Version K19L16**

**YOU MUST READ THIS  
MANUAL BEFORE USE**

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## Section 1: Overview

The Bullseye Precision Gauge Piezo was developed to make vacuum measurement easy, useful and intuitive. The Bullseye Piezo is a rugged portable vacuum instrument that is sensitive and highly accurate. It was designed to suit the demands of field use. Its main features include a graphical LCD display with a white backlight for showing large numerical fonts and digital graphics to show line graphs and time horizons of data from 2 minutes to 2 hours. This graphical display of vacuum pressure makes understanding system trends easy by showing points of inflection and small changes in pressure with sub second resolution.

### Portable

- Rugged design for field or laboratory use
- Dimensions: 6.2" x 3.7" x 1.3"
- Only requires 4 AA alkaline or Micro-B USB to Power

### Precise

- Range of 1 to 775 Torr, -29.92 to 0.59 inches Hg, and mbar
- +/- 2 Torr, +/- 0.08 inches Hg Accuracy
- Numerical graphing display
- Resolution of +/- 0.1 Torr, +/- 0.01 inches Hg
- 12 Units: microns, millitorr, Torr, mbar, Bar, kPa, pascals, PSIA, mmHg, inHg, mmH2O, inH2O

### Reliable

- Isolated sensor – Low risk of sensor contamination
- Battery life of 2800mah/25ma, or 127 hours ~ 5 days (for longer power needs use Micro-B USB)
- Vacuum Interface of 1/8" NPT male or PTFE hose barb, KF/NW adaptable
- CE & RoHS compliant
- Simple, easy-to-use design

### Features

- On/Off soft switch
- LCD graphical, white backlight, sunlight readable
- Large numerical font
- Digital graphics to display line graphs and time horizons of 2 minutes and 2 hours
- 7-foot sensor cable length
- Sensor electrical interface: M12
- Magnet

## Section 2: Quick Start for Bullseye Precision Gauge Piezo

While this vacuum instrument has many features, it is very simple to use. Start by unpacking the unit to verify you've received everything you've ordered.

### Packing List

- Vacuum instrument with white backlight and black rubber boot
- Attached: 7' sensor cable with keyed connector designed to thread directly into the sensor
- Piezo vacuum sensor with 1/8" NPT fitted to 5/16" hose barb
- Quick Start guide or (this) user manual

## Setting Up the Bullseye Piezo

### 1. Power

- Your gauge comes with 4 Pre-installed AA batteries
- Alternatively, you can power by attaching a Micro-B USB power cable
- **To change Batteries:**
  - Remove protective boot
  - Remove the battery cover and install 4 AA batteries then replace the battery cover and protective boot

### 2. Plumb into system

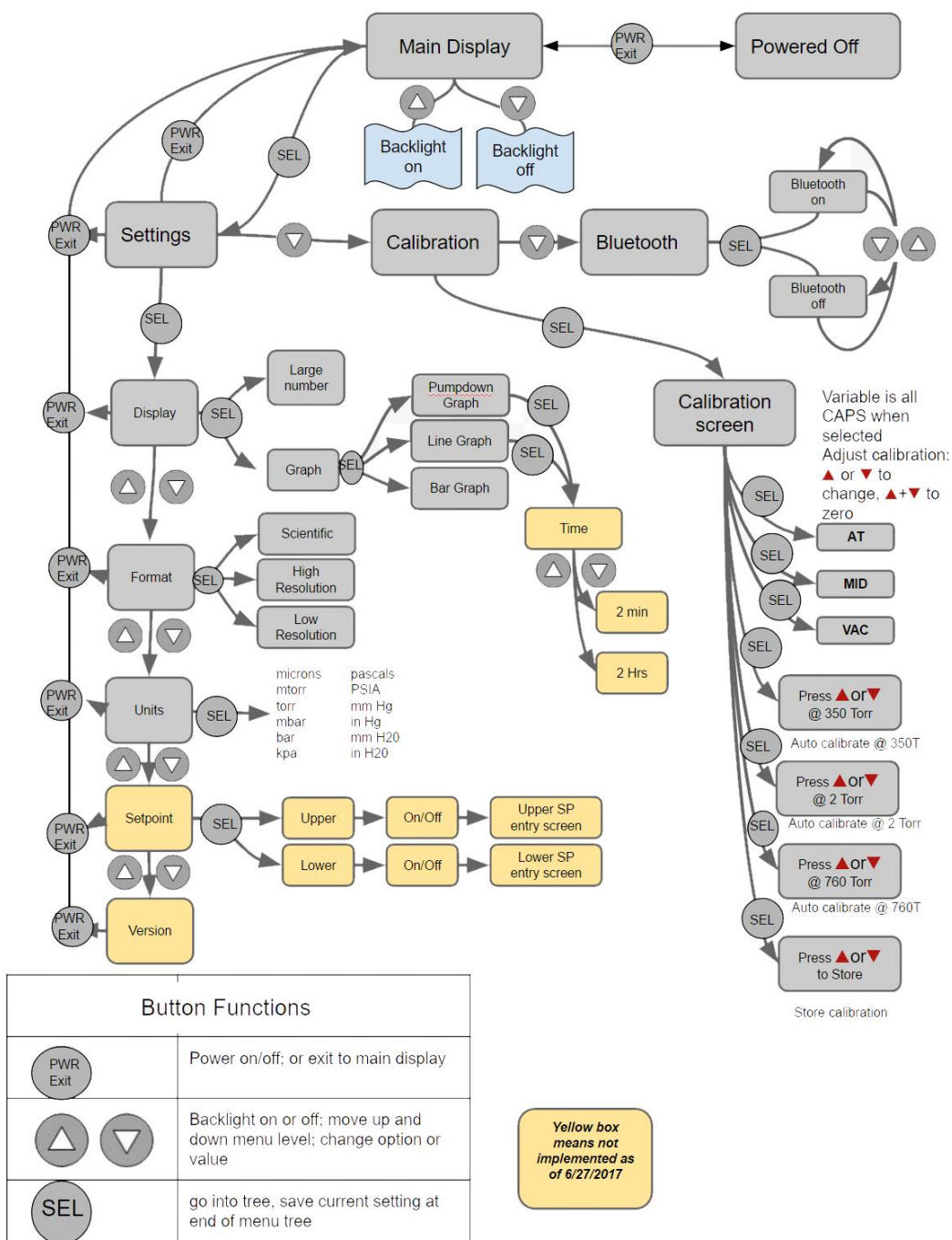
- Plumb the Piezo vacuum sensor into the system to be measured, taking care to differentiate between the threaded end and the end connecting the sensor to the cable
- Attach the sensor cable onto the sensor (cable connector is keyed)

### 3. Get ready to read vacuum

- Power on the device by pressing the PWR/EXIT button. It will take about 5 seconds to fully power up and for the reading to settle.
- If need be, turn on the backlight. The backlight does not affect gauge reading or accuracy.
- Read vacuum!

Feel free to explore the latest copy of this manual at [www.digivac.com](http://www.digivac.com) for all the features that make this a truly useful tool.

## Section 3: Menu Settings Flowchart



## Section 4: Why Piezo?

The Bullseye Precision Gauge Piezo incorporates an isolated Piezo resistive sensor (. A piezo resistive sensor is effectively a silicon strain gauge. When the pressure is placed upon the silicon, the resistance of a MEMS measurement resistor changes which can be measured by the sensor electronics. The sensor itself incorporates a wheatstone bridge that is very sensitive to absolute pressure levels from 1 Torr = 1 mbar to 775 Torr = 1033 mbar.

Piezo resistive sensors are often referred by their full scale or maximum pressure that they measure. For example, our 775i sensor has a maximum pressure sensitivity of 775 Torr or 15PSIA. There are other piezo-resistive types of sensors that are sensitive in other pressure levels. Other pressure levels that are common with piezo resistive sensors are 30 PSI, 100 PSI, 200 PSI and 1000 PSI.

### MEASURE BOTH PRESSURE AND ROUGH VACUUM

Our specialized piezo sensors allow you to easily measure both

Piezoresistive sensors have exceptional durability combined with low cost and better than 1% full scale accuracy. They are chosen when a combination of durability, cost and accuracy are all important.

The accuracy of a piezo resistive sensors are typically given in % of full scale. For example, a 100 PSI piezo sensor that is 1% accurate would have an accuracy of  $\pm 0.01 * 100 \text{ PSI}$  or  $\pm 1 \text{ PSI}$ . Note this makes the % of reading accuracy very good near its full range of 100 PSI, but not so good near its base pressure (lowest detectable pressure) of 1 PSI. The 775i sensor has an accuracy of  $\pm 2 \text{ Torr}$ , or 0.25% of full scale. This would make its accuracy at 10 Torr  $\pm 2/10$  or  $\pm 20\%$  of reading at an actual pressure of 10 Torr and at 200 Torr,  $\pm 2/200$  or 1% of reading.

### TWO SENSOR OPTIONS FOR VERSATILITY

Choose from two different sensors based on your specific needs

### Sensor Specifications

	BPG Piezo 775i	BPG Piezo Vac2PSI
Sensor Method	Direct	Direct
Sensor Protection	Isolated	Isolated
Full Range	0.5 - 775 Torr	20 Torr - 85 PSIG
Most Accurate Range	2-775 Torr	50 Torr - 85PSI
Accuracy	+/- 2 Torr	+/- 15 Torr +/- 0.5 PSI
Target Application	Rotary Evaporation, Falling Film	Rotary Evaporation, Extraction

The most important thing about accuracy is knowing what you need for your process. You should choose the sensor that meets your needs. All sensors have tradeoffs of cost, type of reading technology, and accuracy.

For example, a more accurate alternative to the Bullseye Piezo is a 1000 Torr capacitance manometer. Some can be had at 0.15% of reading and are also isolated. However, they tend to be expensive, don't travel well (easily damaged), and require frequent maintenance to maintain that accuracy, especially around 10 Torr. The Bullseye Precision Gauge Piezo was built from the ground up to be rugged and thrive with field use.

## ISOLATED SENSORS

### For use in dirty environments or where corrosive gases are in use

The isolated part of the sensor is important. Isolated means that the sensing electronics are separated and protected from the process gas pressure being measured.

### When do you need an isolated sensor?

When measuring clean dry gasses, isolated doesn't matter. Non-isolated sensors where the silicon die of the piezo resistive encounters clean dry gasses (like air and nitrogen) will work. These electronics can survive a lifetime exposed to clean dry air and even low humidity or an occasional splash of water (when not energized).

**Isolated is needed in corrosive environments:** Corrosive gasses on the other hand will corrode the silicon die and wires that make up a sensor just like the ocean would corrode a steel bolt thrown into it. Over time the sensor will degrade and cease to operate. The isolation in the 775i and the Vac2PSI sensor is achieved through a stainless-steel diaphragm that comes in contact with the media to be measured, commonly called the wetted surface. These sensors will operate fine in diesel fuel, gas, nitrogen, alcohol, or other corrosive environments.

The only time these sensors may degrade is when substances calcify on the stainless-steel diaphragm preventing its movement. If the readings seem sluggish, check the sensor. When in doubt, use an otoscope to look in the sensor to see if any foreign matter is stuck near the diaphragm. Wash out with solvent, but do not poke the diaphragm. If the foreign matter is still obvious then it may be time to replace the sensor. The sensors are easily replaced and have excellent interchangeability. Isolated sensors are immune to damage from corrosive processes and materials.

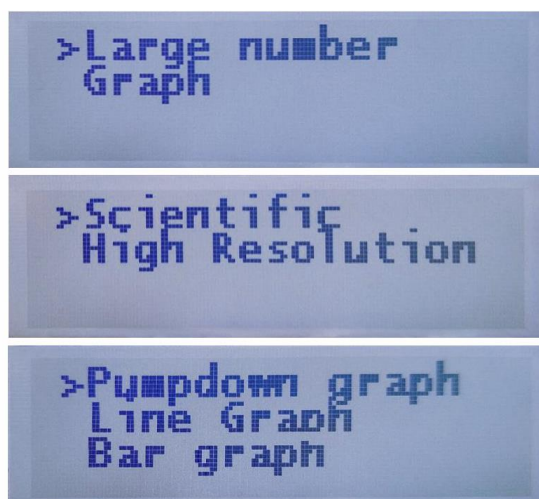


## Section 5: Display Options

The Bullseye Piezo has two modes of display: numeric and graphical. The graphical display mode features a line graph with time horizons of 2 minutes or 2 hours.

### Display Options

The numeric display has three numeric formats: Low Resolution, High Resolution and Scientific Notation.



Display modes are selected from the display menu and numeric formats are selected from the Setting option "Display". The SEL button enters and traverses the Settings menu.

The numeric display shows the currently configured units. In these examples, the vacuum pressure units are "mbar" or "torr".

In any display mode, the **UP** and **DOWN** buttons turn the backlight on and off (respectively), the **SEL** button enters the configuration menu, and the **PWR/EXIT** button turns the gauge on or off.

### Display Bar Graph

The bar graph visualizes the current sensor reading with a 6-stage stepped bar.



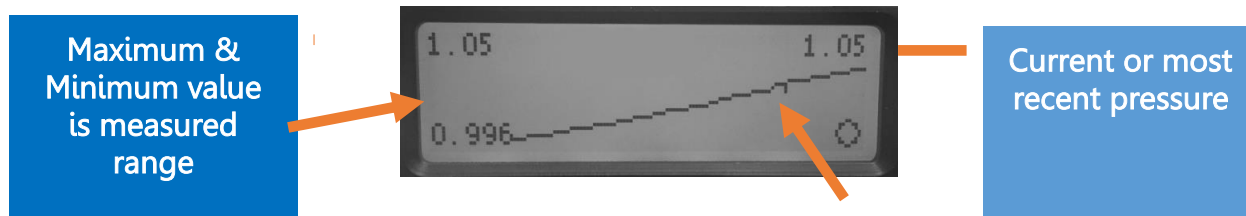
The pump down graph plots time horizontally and log pressure vertically. The vertical pressure scale is logarithmic, indicating order of magnitude from less than 1 Torr to



atmosphere.

## Display Line graph

The **auto-scaling (or, auto-ranging) time graph** is a *microscope* into the pump down data.



In this mode, the **pump down graph** is shown with a **linear pressure scale** that is fit to the pressure range of the data set.

The height of the graph display is the pressure range of the data set in a **linear scale** (not log). The top left figure is the **maximum value in this range**, and the bottom left figure is the **minimum value in this range**. The top right figure is the **current or most recent value** in the instrument.

**Please Note:** Sometimes this visualization is not useful, showing noise. This noise comes from the instrument's process of measurement, as well as the vacuum system under measurement. In this sense, the auto scaling graph is a data visualization microscope.

**Useful Quick Tip:** This visualization can show a very small climbing or descending trend that the vacuum analysis algorithm has not declared as a leak or pumping.

## High Resolution

The High-Resolution format has three digits of precision. For example, an internal vacuum value of 1234 millitorr ( $\mu\text{m Hg}$ ) would be displayed as 1.23 Torr in the Precision numeric format with Torr units. Additionally, this format gives the raw vacuum measurement data which may be useful for trending but may result in a noisier reading.

## Scientific

The scientific format has two digits of precision with a base ten exponent following conventional usage. For example, an internal vacuum value of 52 Torr (mm Hg) would be displayed as  $5.2 \times E^{+1}$ .



### Display Large number

Numeric display with the “High Resolution” format

Large number display with the “scientific” format



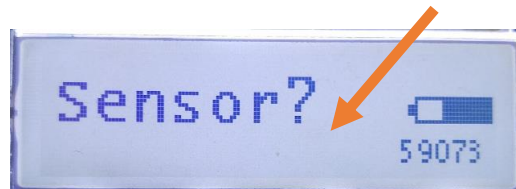
The numeric display shows the currently configured units; in these examples the vacuum pressure unit is “Torr”.

In any display mode, the **UP** and **DOWN** buttons turn the backlight on and off (respectively), the **SEL** button enters the configuration menu, and the **PWR/EXIT** button turns the gauge on or off.

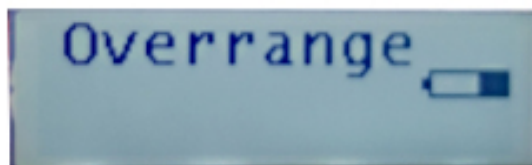
The battery indicator shown at full strength



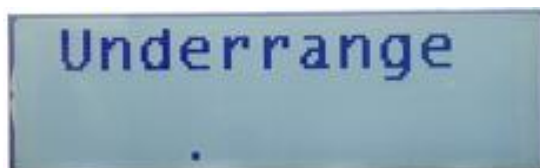
The numeric display shows when the **vacuum sensor** is disconnected or failed



The numeric display shows **overrange** when the vacuum pressure is above the useful range of the BPG-775i



The numeric display shows **under range** when the vacuum pressure is below the useful range of the BPG-775i



## Section 6: SERVICING AND MAINTENANCE

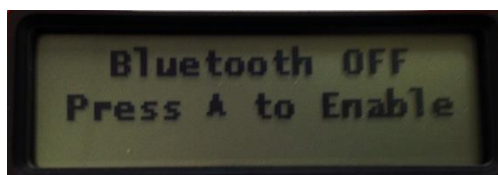
### GAUGE TUBE SERVICING

In many cases, a gauge sensor may become fouled with oil or other foreign matter, but the 775i sensor is isolated so there is less risk for contamination. It is however, recommended that the sensor be checked regularly and cleaned as needed. If you would like to review how to clean a sensor, you can find one on thermocouple sensor cleaning [here](#).

### Bluetooth Models Operation

For Bluetooth Models: Bullseye Piezo comes equipped with a Bluetooth module, which interfaces with the Vacuum Gauge Application for remote, real-time vacuum monitoring via Apple Store at <https://appsto.re/us/B1lx5.i>, or Google Play Store at <https://play.google.com/store/apps/details?id=com.digivac.bullseye> ranging up to 300 feet under ideal conditions.

To enable Bluetooth monitoring, scroll to the menu section marked Bluetooth, and enable or disable the signal with the up or down arrow. See the included Vacuum Gauge Application instructional addendum to enable app functioning.



## Maintenance

The **Bullseye Precision Gauge Piezo** is designed for trouble free use with little or no maintenance required. A few best practices should be followed. While not required for accuracy, it is best to mount sensor in stem down orientation where the threads are down towards the ground, and the wire is up. This will facilitate draining of any foreign matter from the sensor to help mitigate physical obstruction of the diaphragm.

Keep the measurement unit clean and dry to prevent foreign matter or water from entering the display and controller electronics. The unit is not waterproof, so splashes of water while the gauge is powered on can damage the electronics. If a weatherproof version is required, consult DigiVac.

## NOTES ON CALIBRATION

There is inherent drift in all sensors including the DigiVac piezo sensors. Drift is specified in the datasheet, but the specification is typically a worst-case scenario as drift is not easily predicted and depends on operating environment. DigiVac offers calibration services, including NIST calibration which provides vacuum data on the gauge. This could be useful to help you determine when the gauge has drifting out of your determined specifications and will help you determine your optimal calibration schedule. All DigiVac gauges are sold calibrated against a NIST standard, but only those purchased with a NIST calibration come with the data. You can pull this information yourself, when you are first using the gauge to determine its measurement parameters. Having this information will allow you to determine the optimal calibration interval. The generally accepted calibration interval is 1 year but depends on what accuracy you require and your standard operating procedures.


Note the sensors have excellent accuracy by themselves. Additional accuracy is gained by calibrating the sensor controller (the thing with the display and cable coming out of it) to the sensor. The sensor itself cannot be calibrated, but the sensor-controller pair is. **Note:** that the 775i sensors accuracy applies to any type of measurable gases. Readings will be the same regardless of the type of gas you are trying to measure.

## Vacuum Calibration



The calibration screen contains the numbers necessary to calibrate the gauge to a known good standard. The “Vacuum” number on in the top right corner is millitorr x 10. For example, in the above picture 1.3 Torr is displayed. The next number is counts, which is an internal number that literally represents what is coming into the microcontroller’s A2D converter and is a useful diagnostic. The numbers on the bottom are:

- 760T – the Atmospheric pressure calibration number
- 3T – the vacuum or low-pressure calibration number

These numbers on the bottom represent the digital calibration points to be adjusted in order to achieve optimal calibration. There are 2 ways to calibrate: Manually and Automatically. Press the circular arrow Select button  to cycle through the calibration presets. Each function will capitalize when highlighted.

### Automatic Calibration Procedure:

1. Press select until you get to calibration mode
2. Press select until you get to automatic
3. Set the manifold to 5.0 Torr
4. Press up and down simultaneously
5. Set the manifold 760.0 Torr
6. Press the up and down arrows simultaneously
7. Press up and down again simultaneously to store (This is the step where the calibration numbers get stored)

At pressures above 775 Torr, the unit may display the text “Overrange”; this is typical as this is the sensor's highest rated pressure range. For optimal accuracy, readings above 775 Torr, if displayed at all, should not be used for precision readings.

\*The screen will go negative when the up and down arrows are pressed simultaneously to indicate the success of the button push.

## Section 7: Accuracy

### Instrument Repeatable Accuracy

Range	Accuracy
1 ~ 775 Torr	+/- 2 Torr
1 ~ 1033 mbar	+/- 2.665 mbar
0.59 ~ -29.88 inches of Hg	+/- 0.08 inches of Hg

## Section 8: SPECIFICATIONS

### SPECIFICATIONS

#### Power

4 AA Batteries

#### Vacuum Interface

1/8" Male NPT

#### Units

Torr, millitorr, microns, mbar, bar, kPa, Pa, mm H<sub>2</sub>O, mm of Hg, inches of Hg, inches of water, PSIA

Sensor Specifications	BPG Piezo 775I	BPG Piezo Vac2PSI
Sensor Method	Direct	Direct
Sensor Protection	Isolated	Isolated
Full Range	0.5 - 775 Torr	20 Torr - 85 PSIG
Most Accurate Range	2-775 Torr	50 Torr - 85PSI
Accuracy	+/- 2 Torr	+/- 15 Torr +/- 0.5 PSI
Target Application	Rotovap, Falling Film	Rotovap, Extraction
Certification	CE, CSA, UL, RoHS	CE, CSA, UL, RoHS

#### Mount

Portable Handheld

#### Dimensions

6.2"H x 3.7"W x 1.3"D

#### Wetted Materials

316 Stainless Steel

#### Connectivity and Outputs

Bluetooth and [vacuumnetwork.org](http://vacuumnetwork.org)

#### 3 Meter Sensor Cable Length

Long cable length for portability & field use

## Specifications

Vacuum Reference:	Absolute
Sensor:	Piezo P/N SEN-775i-NPT
Resolution:	+/- 0.1 Torr, +/- 0.01 inches Hg
Units:	Torr, microns, mbar, bar, kPa, inches of Hg, mm Hg, millitorr, inches of water, PSI, Pa
Accuracy:	+/- 2 Torr, +/- 0.08 mbar
Range	1 to 775 Torr, -29.88 to 0.59 inches Hg
Mount	Desktop, Desktop with kickstand or strong magnet
Display	Graphical with LCD
Product Dimensions	6.2" x 3.7" x 1.3"
Power	4 AA batteries or Micro-B USB
Compliance	CE and RoHS
Wetted Materials	316SS
Numeric and graphical displays	See your vacuum readings in either numbers or easy to read graphs
Bluetooth Capabilities (with Bluetooth models)	Receive your pressure readings on your phone or tablet with the DigiVac app
Digital Graphs	Easily view line graphs and time horizon of 2 minutes and 2 hours
7-foot Sensor Cable Length	Long cable length for portability and field use
Stability	+/- 0.25% per year
Proof Pressure	60 PSI
Burst Pressure	200 PSI

## Section 9: Units of Measurement

This instrument is calibrated in microns or "millitorr." **Understanding Microns:** Microns are not really a measure of vacuum at all, but rather of absolute pressure.

**The pressure of the atmosphere is 14.696 or approximately 14.7 pounds per square inch at sea level. One TORR is an absolute pressure of one millimeter of mercury. A millitorr is equal to one thousandth of a TORR. A MICRON is the same as a millitorr.**

This pressure is due to the weight of all the air in the earth's atmosphere above any specific square inch. Note: 14.696 PSI is equivalent to the pressure produced by a mercury column approximately 29.92 inches high or .76 meters (~ 3/4 of a yard) or 760 millimeters of mercury.

Atmospheric pressure varies greatly with altitude. It decreases approximately 1 inch of mercury per thousand feet of altitude. It also varies with local weather conditions. (Variations of 0.5 inches in a day are common.) The word "**vacuum**" means pressure lower than atmosphere. However, in describing negative pressure, the atmosphere is only a satisfactory reference if we are dealing with vacuum levels



down to about 27 inches of mercury. Below that, it is more useful to talk in terms of **absolute pressure**, starting from absolute zero, which is how the Bullseye Precision Gauge Piezo operates.

## Section 10: Options

Product	Part Number	Interface	CE/ RoHS	Features/Benefits
Bullseye Hard Case	CAS-HARD-BPG		Y	Hard Case with protective form fitting foam insert designed to protect Bullseye, with room for fittings
Bullseye Soft Case	CAS-SOFT-BPG		Y	Soft Carrying Case for Bullseye Vacuum Gauge, with Digivac Logo
KF25 Adaptor	ADP-KF25		Y	1/8" FNPT to KF25 Adaptor
1/4" barb adaptor	ADP-1/4"		Y	1/8" FNPT to 1/4" ID hose barb
5/16" barb adaptor	Adp-5/16"		Y	1/8" fnpt to 5/16" id hose barb
3/8" barb adaptor	Adp-3/8"		Y	1/8" FNPT to 3/8" ID hose barb

## Section 11: Bluetooth Connectivity



### Bluetooth

- Versatile digital vacuum gauge that you can monitor right from your phone or tablet ([Apple ios](#) and [android](#))
- Enables remote monitoring and troubleshooting
- Set low and high alarm from your phone
- [Email vacuum data](#) to document leaks, baseline pressure or pump-downs

### Portable and Precise

- Rugged thermocouple vacuum gauge ideal for understanding: Leaks, Pump Downs, Outgassing or Stable Systems
- Includes a powerful magnet and kickstand to enable hands-free operation
- Long battery life and versatility with 12 different measuring units (micron, Torr, Inches of Hg, kPa, Inches of H2O, millitorr, mbar, Pa, PSIA, mm of Hg, bar, and mm of H2O)
- Calibrated under actual vacuum against a NIST standard

## Graphing and Analysis

- Patent Pending vacuum graphing displays vacuum and time data
- Visual graphing right on the display that identifies current system status
- Vacuum Analytics to quickly identify vacuum pressure trends
- Graphical display for quick determination of vacuum level



**Android:** Links via Bluetooth Low Energy to Bullseye Piezo with Bluetooth to view, alarm, log readings and email data for graphing pump down curves. Ideal for vacuum pump test or finding leaks. For the medium vacuum range with typical measurements in the micron or millitorr range.



**Apple:** Links via Bluetooth Low Energy to Bullseye Piezo with Bluetooth to view, alarm, log readings and email data for graphing pump down curves. **Compatibility:** Requires iOS 7.0 or later. Compatible with iPhone, iPad, and iPod touch.

## Section 12: TERMS OF USE, LIMITED WARRANTY & LIABILITY WAIVER

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