



Instruction Manual

DRPG-531

Portable Battery Operated Gauge Control/Display
For Use With DST-531 Thermocouple Sensor



Table of Contents

I.	Overview	p. 4
II.	Quick Start for DRPG-531	p. 5
III.	Modes of Display	p. 7
	A. Display Numeric	
	B. Display Bar Graph	
	C. Display Pumpdown Graph	
	D. Display Line Graph	
IV.	Menu of Configuration Settings	p. 10
	A. Display	
	B. Numeric Format	
	1. Precision	
	2. Standard	
	3. Scientific	
	C. Setpoint Value	
	D. Setpoint Action	
	E. Pumpdown Time	
	F. Auto-off Time	
	G. Sound	
	H. Self Test	
	I. Units	
	J. Units - Pumpdown Rate	
	K. Calibration	
	L. Version	
V.	Auto-Off Operation	p. 14
VI.	Set Point Operation	p.14
VII.	Vacuum System Analysis	p.17
	A. Data Set Size	
	B. Differential Analysis	
	C. Reset	
VIII.	Self-Test Operation	p.16
IX.	Field Calibration	p.16
	A. Calibration Parameters	
	B. Calibration Functions	
	C. Calibrating the Instrument	

X.	Understanding TORR	p.19
XI.	Servicing and Maintenance	p.20
	A. Gauge Tube Servicing	
	B. Maintenance	
	C. Factory Repair and Calibration	
	D. Notes on Calibration	
XII.	Instrument Accuracy	p. 21
XIII.	Specifications	p. 21
XIV.	Terms of Use and Limited Warranty	p. 22

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I. Overview

The DRPG-531 precision vacuum gauge was built to be a rugged, portable vacuum measurement instrument designed specifically for the demands of field use. First and foremost, it is a highly accurate vacuum gauge using field proven thermocouple sensor technology. The DRPG-531 precision gauge offers several viewing options including numeric, bar graph and pumpdown display.

Portable

- Rugged design offers a super-strong magnet for hands-free operation.
- Field-proven thermocouple vacuum sensing technology

Precise

- Accuracy available in 12 different measurement units
- Field calibratable

Reliable

- 70 hour battery life
- Protective rubber boot
- Simple, easy to use design

Features

- Auto OFF
- On/Off Soft Switch
- Battery level indication
- Good/Bad tube indication
- Self test mode
- 3 different graphical displays of vacuum pressure
- Vacuum Analytics for leak, outgassing and pump down

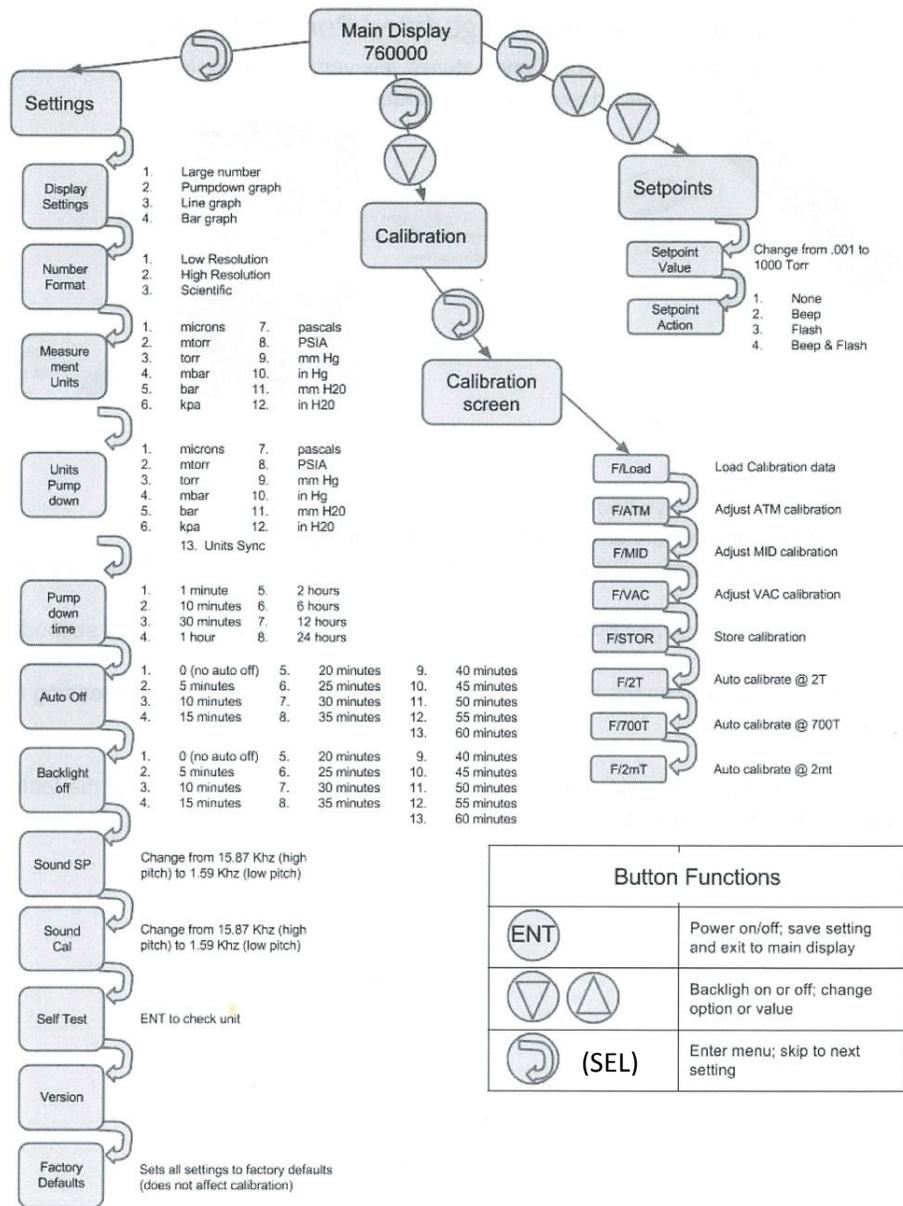
II. Quick Start for DRPG-531

While this vacuum instrument has many features, it is very simple to use. First, unpack the gauge to be sure that you have received everything that you ordered.



Next:

1. Remove protective hood
2. Remove the battery cover and install 4 AA batteries.
3. Plumb the thermocouple sensor into the system to be measured, taking care to keep the stem down.
4. Power on the device by pressing the 'PWR' button. It will take about 5 seconds to turn on.
5. If need be, turn on the backlight. The backlight does not affect gauge reading or accuracy.
6. Read vacuum!



III. Modes of Display

The DRPG-531 has four modes of display: one numeric and three graphs. The numeric display has three numeric formats: Standard, Precision and Scientific. Display modes are selected from the Configuration option 'Display' and Numeric formats are selected from the Configuration option 'Numeric'. The SEL button enters and traverses the Configuration menu.

A. Display Numeric

The following example shows the numeric display with the 'Precision' format:



The following image shows the numeric display with the 'Scientific' format



The Numeric display shows the currently configured units, in these examples, the vacuum pressure units are 'microns' or 'Torr'. Below the units indicator are the battery, vacuum pressure, and vacuum system analysis indicators.

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 **ENT** button turns the gauge on or off.



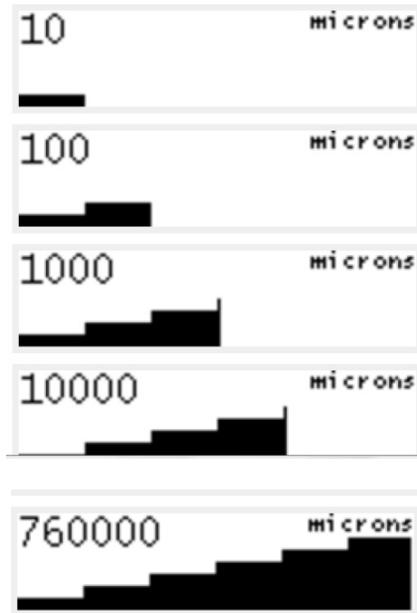


In the previous example, the battery indicator is shown at full strength and the vacuum pressure indicator is shown in its second of three (logarithmic/ order of magnitude) levels. The following example shows the numeric display when the vacuum sensor tube is disconnected or has failed.



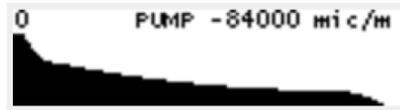
B. Display Bar Graph

The bar graph visualizes the current sensor reading with a stepped bar



C. Display Pump-Down Graph

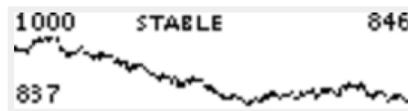
The Pump-Down graph plots time horizontally and log pressure vertically. The horizontal time scale is selected using the Configuration option 'Pumpdown Time' The vertical pressure scale is logarithmic indicating order of magnitude from one micron to atmosphere.



In the top left is the current vacuum pressure display figure. In the center of the first line is the Vacuum System Analysis, 'PUMP' and to the right is either the pump down rate in units per minute or the data set window size in hours, minutes and seconds. The 'STABLE' case shows the data set window size (ex: '1m18s')

D. Display Line Graph

This auto-scaling (or auto-ranging) time graph is a detailed view of 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 the range, and the bottom left figure is the minimum value in the range.

The top right figure is the current or most recent value in the instrument.

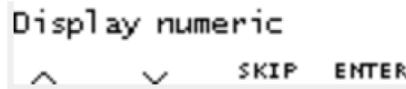
Sometimes the visualization is not useful, showing noise. The noise comes from the instrument's process of measurement, as well as the vacuum system under measurement. In this sense, the auto-scaling graph is a data visualization tool.

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

IV. Menu of Configuration Settings

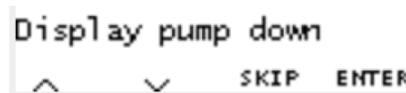
A. Display

Pressing the **SEL** button from the vacuum display screen will present three sub-menus: Display, Calibration and Setpoints.



The display menu is a linear series of options that are stepped or skipped through using the **SEL** button.

Above each button is a utility hint to indicate specific button function. The **SKIP** button is above the **SEL** button to indicate that the **SEL** button is used to step or skip to the next menu screen with no configuration change. The **ENTER** hint above the **ENT** button indicates that the button is used to enter the display mode as shown in the menu screen.

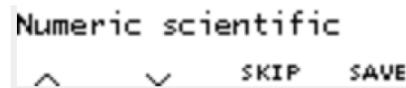


Using the **UP** or **DOWN** buttons will change the option available on the **MENU** screen. In the example above, the configuration menu is ready to change the display to the **PUMPDOWN** Graph. In this state, pressing the **ENTER** button will change the display to the **PUMPDOWN** graph, or pressing the **SKIP** button will ignore the state of the menu screen and leave the Display mode unchanged.

B. Numeric format

The Numeric Format setting defines the vacuum pressure format throughout all modes of display.

The **UP** and **DOWN** buttons select a format type from Precision, Scientific and Standard , and the **ENT** button saves the current choice.



1. Precision

The **Precision** format has three digits of precision. For example, an internal vacuum value of 1234 microns ($\mu\text{m Hg}$) 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.

2. Standard

The **Standard** format has two digits of precision. For example, an internal vacuum value of 1234 microns ($\mu\text{m Hg}$) would be displayed as 1.2 Torr in the **Standard** numeric format with Torr units. This number format also gives a filtered number depending on the accuracy of the gauge in the pressure range of measurement. For example, it may count by 50 Torr around 100 Torr since the accuracy in this range is ± 50 Torr, which results in a 'quieter' gauge.

3. Scientific

The **Scientific** format has two digits of precision with a base ten exponent following conventional usage. For example, an internal vacuum value of 1234 microns ($\mu\text{m Hg}$) would be displayed as 1.2×10^0 Torr. For any resolution below 2 milliTorr, the **Scientific** format must be used.

C. Setpoint value

The **Set Point Value** is defined in terms of the current vacuum pressure units.



The Set Point indicates a pump down to configured pressure state according to the setting of the Set Point Action. See 'Set Point Operation' for more detail.

D. Setpoint action

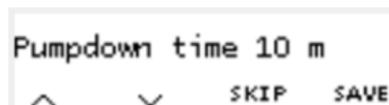
The Set Point Action is defined as one of a set of choices, including: None, Beep, Beep and Flash, or Flash.



For details of operation, refer to the section 'Set Point Operation'.

E. Pumpdown time

The pumpdown time configuration option defines the width of the Pumpdown Graph and pumpdown rate window.



The pumpdown rate is the difference between the start and end of the pressure data shown in

the pumpdown graph. For example using a pump down time of ten minutes, a system pump down from atmospheric pressure to one Torr in ten minutes has a pump down rate of 760 Torr per ten minutes or 76 Torr per minute.

F. Auto Off time

Use this setting to save battery power during periods of inactivity. The figure zero will disable the auto off battery saver feature. To see the specifics of this feature, look at the **Auto Off Operation** section.



With a positive (non zero) value, the unit will indicate the Auto Off.

G. Backlight time

Use this setting to save battery power during periods of inactivity. The figure zero will never turn off the backlight. Setting the Backlight time to some number of minutes means the backlight will turn off after that number of minutes.

H. Sound

The two sound configurations determine the audible Set Point Alarm and Calibration Storage Acknowledgement tones, named 'Sound SP' and 'Sound Cal' respectively.

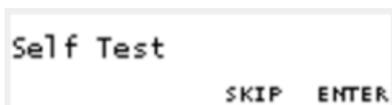


The Set Point Alarm sound is typically configured to a different value from the Calibration Acknowledgement sound.



I. Self Test

The self test function reviews the Tube and Battery status, and resets the internal Elapsed Time Clock, Pump Down Data, and Auto Off subsystems.



Enter the Self Test sequence with this option. Refer to the section ‘Self Test Operation’ for more detail.

J. Units

The units settings permits numeric vacuum values to be displayed in any one of a 12 available vacuum pressure units including microns, millitorr, millimeters of mercury, Torr, mbar, Bar, Pa, kPa, inches of mercury, mm of water, inches of water and PSIA. Note that inches of mercury and inches of water is zero referenced to 760 Torr absolute pressure.

Quick Note: A negative number indicates vacuum, a positive number indicates pressure relative to sea level.



K. Units pumpdown rate

The units pumpdown configuration option permits the pumpdown rate figure displayed in the Pumpdown Graph to employ identical or different units from the numeric vacuum units. Use this option to change the pumpdown rate units. This option has been included to support work with multiple sources of technical documentation for the vacuum system, and vacuum system pump down.



The ‘Sync’ option, shown in this example (above), maintains the pumpdown rate units as identical to the primary vacuum units. Of course this is the recommended configuration, as employing mixed units could be a source of misunderstanding.

L. Calibration

This configuration option is available from the main menu and will enter the field calibration mode.



Refer to the section ‘Field Calibration’ for a complete description of the operation of the Calibration function.

M. Version

The last step in the configuration menu reports the software version identifier.



Version K13E07

This software version identifier is useful for communicating with the factory or distributor support.

N. Factory Defaults

The last step in the settings screen will return all the settings to factory defaults. This does not affect calibration. Tap the 'reset' button to restore factory default.

V. Auto Off Operation

The auto off feature has been defined as an unattended mode of operation to not conflict with other unattended modes of operation. The Ruggedized Portable Gauge will not turn itself off when:

- connected to a system under vacuum (less than 100 Torr, pump down feature set)
- initially filling the pump down data set (pump down feature set)
- not timed out since pump down or button activity
- in calibration mode

VI. Set Point Operation

A Set Point may be defined to beep (configured sound) or flash (invert display) when a low pressure vacuum has been achieved.

The Set Point Value is defined with the Configuration option 'Set point V units' for V between one micron and atmosphere.

The Set Point Action is defined with the Configuration option 'Set point A' for A one of 'None', 'Beep', 'Flash', 'Beep & Flash'.

The Set Point Alarm is raised on successfully achieving the objective vacuum pressure (Set Point Value).

The Set Point Alarm is lowered, but not cleared, on pressing any button while the alarm is raised (display flashing or beep sounding).

The Set Point Alarm is cleared, and is ready to be raised again, when the pressure in the system under test rises well above the Setpoint Value.

VII. Vacuum System Analysis

The result of the Vacuum System Analysis is one of 'PUMP', 'LEAK', 'OUTGAS' or 'STABLE' and is shown in some display modes.



Internally, one data set serves the Pump down and Time Auto line graphs as well as the Vacuum System Analysis. The data is visualized in the Pump down and Time Auto line graphs. The data set is maintained continuously in every mode of operation.

A. Data set size

The width of the data set in time is configured with the option 'Pumpdown time'. This figure is employed to determine the time slices that are accumulated at a rate of roughly three updates per second. A small difference will accrue to the actual data set span in hours, minutes, and seconds. The Pump down graph with a 'STABLE' case (under 100 Torr) will display the actual time window size in hours, minutes and seconds.

B. Differential Analysis

The Vacuum System Analysis looks at the last quarter of the pump down data set to determine the state of the system under test. The whole analysis is recomputed approximately three times per second.

The 'LEAK' result indicates pressure increasing towards atmosphere with rates that are not typically indicative of outgassing alone.

The 'PUMP' result indicates a *strong* pressure descent to vacuum as for a system under vacuum pump down.

The 'OUTGAS' result indicates evidence of outgassing. Evidence of outgassing is a pressure trend that is ascending at a rate that is decreasing. Eventually the rate of ascent decreases until the pressure stabilizes.

The 'STABLE' result indicates no particular evidence of venting (LEAK) or outgassing, and is shown for slow pump down rates for the benefit of the experience of working with the instrument.

The 'STABLE' case partially obscures some (weak) 'PUMP' cases in order to stabilize the instrument display.

C. Reset

The pump down data set is cleared in poweroff states: turned off, or dead or missing batteries.

VIII. Self Test Operation

The Self Test feature is available from the Configuration option 'Self Test', pictured below.



From this Configuration option, press the **ENT** button to enter the Self Test sequence. The Self Test sequence proceeds on any button press through a set of steps. The first step in the Self Test sequence, shown below, performs tests of the Battery level and Tube connection.



Pressing any button will increment the Self Test sequence to the second step, shown below.



The second step reviews the detailed results of the tests performed in the preceding step. Pressing any button will proceed to the third step.



The third step reports the overall condition as **GOOD** or **NOT GOOD**, based on the results reviewed in the previous step.

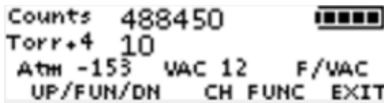
Pressing any button will exit the Self Test and reset the Elapsed Time Clock and dependent subsystems including the Pump Down Data Set as occurs on any power off state (turned off or batteries dead or missing).

IX. Field Calibration

From the Settings view, choose 'Calibration', pictured below, press the **ENT** button to enter the field calibration mode.



The field calibration mode, shown below, shows digital signal counts and Torr pressure times 10,000 ('Torr x 10⁺⁴'). For example, one micron (or millitorr) is '10' in the 'Torr x 10⁺⁴' scale.



Counts 488450
Torr*4 10
Atm -153 VAC 12 F/VAC
UP/FUN/DN CH FUNC EXIT

A. Calibration parameters

The calibration method employs a ‘zero, mid and span’ model. The ‘ATM’ parameter is modified to align to **760 Torr**, and the ‘VAC’ parameter is modified to align to **5 millitorr**. In the ‘Torr x 10⁺⁴’ scale employed in the Calibration mode, these pressures are represented with the figures **760000** and **50**, respectively.

B. Calibration functions

The Calibration mode operates using a function concept. The current function is one of eight available functions (operations) and is shown above the **EXIT** button hint as ‘**F/LOAD**’ in this example.

The four functions are **F/LOAD**, **F/STORE**, **F/ATM**, **F/MID**, **F/VAC**, **F/2T**, **F/700T**, and **F/2mT**.

The **SEL** button changes the current function among these four possibilities.

Functions F/ATM, F/MID and F/VAC

The **F/ATM** and **F/VAC** functions enable the **UP** and **DOWN** buttons to change these parameter values. As these parameter values change, the internal pressure value register shown in the Calibration display (at ‘Torr x 10⁺⁴’) is modified.

Quick Note: These values are not saved for use beyond the calibration session until they are stored using **F/STORE**.

Functions F/2T, F/700T, and F/2mT

The **F/2T**, **F/700T** and **F/2mT** is a calibration shortcut. When in the function mode **F/2T**, when the vacuum in the manifold is exactly 2 Torr against a known standard, press the **UP** and **DOWN** buttons simultaneously to adjust the MID calibration point to the correct value. In a similar way, **F/700T** and **F/2mT** is used.

Functions F/LOAD and F/STORE

The **F/LOAD** and **F/STORE** functions read and write parameters from and to persistent memory (long term storage).

One of these two functions is available when the function indicator above the **EXIT** hint shows **F/LOAD** or **F/STORE**. In this case, *pressing and releasing* the **UP** and **DOWN** buttons together will execute the function. When the function has been successfully executed the display will flash, and an audible beep will sound (with the tone configured in ‘**Sound Cal**’).

Quick Note: Completing a calibration session requires execution of F/STORE in order to save the parameters to persistent memory before exiting. Exiting a calibration session without successfully executing the F/STORE function will discard the calibration parameters.

C. Calibrating the instrument

Note: Calibration always happens in Torr measurement units.

1. Set Cal points **VAC**, **MID** and **ATM** to zero
 - a. A shortcut for setting a variable to zero is to set the unit to the desired variable, such as **F/VAC**
 - b. Press the **UP** and **DOWN** buttons together. That variable will now be zeroed.
2. Set the manifold to exactly 2 Torr according to a known standard, then set the '**F/MID**' such that the unit reads exactly 2 Torr, or '2000 0'
 - a. A shortcut for setting the **MID** is to change the function to '**F/2T**'
 - b. Then press the **UP** and **DOWN** buttons together. This will optimally set the **MID** calibration point.
3. Set manifold vacuum to 760 Torr, and adjust '**ATM**' so the Ruggedized Portable Gauge reading reflects Standard +/-10 Torr
 - a. A shortcut for setting the **ATM** is to change the function to '**F/700**', and set the manifold to 700 Torr
 - b. Then press the **UP** and **DOWN** buttons together. This will optimally set the **ATM** calibration point.
4. Set manifold vacuum to .005 Torr, and adjust '**VAC**' so the Ruggedized Portable Gauge reading reflects standard +/-0.001 Torr
 - a. A shortcut for setting the **VAC** is to change the function to '**F/2mT**', and set the manifold to 2 milliTorr.
 - b. Then press the **UP** and **DOWN** buttons together. This will optimally set the **VAC** calibration point.

5. F/Store

6. Check **ATM** is +/-20 Torr
7. Check **Vac** is +/-0.002 Torr
8. For calibrating unit for repeatable sub millitorr readings, calibrate 2 millitorr at the ambient temperature at which you will be using the gauge. Let the vacuum system sit at 2 millitorr for 10 minutes, then calibrate. The settle time for an accurate reading below 1 millitorr is approximately 2 minutes.

X. Understanding Torr

This instrument and many similar instruments are calibrated in microns or 'millitorr.' It is appropriate to discuss what microns are and to relate microns to other measures of pressure and vacuum. Microns are not really a measure of vacuum at all, but rather of absolute pressure. It will be recalled that the pressure of the atmosphere is 14.696 or approximately 14.7 pounds per square inch at sea level. This pressure is due to the weight of all of the air in the earth's atmosphere above any particular square inch. This 14.696 PSI is equivalent to the pressure produced by a mercury column of approximately 29.92 inches high or .76 meters (about 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 widely with local weather conditions. (Variations of one half inch in a single day are common.) The word vacuum means pressure lower than atmospheric or 'suction,' but, in describing negative pressure, the atmosphere is only a satisfactory reference if we are dealing with values of vacuum down to about 27 inches of mercury. Below that, it is much more useful to talk in terms of absolute pressure, starting from absolute zero. The Ruggedized Portable Gauge and all similar instruments do just this.

One Torr, a commonly used unit, 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.

XI. Servicing and Maintenance

A. Gauge Tube Servicing

In many cases, a gauge tube may become fouled with oil or other foreign matter. It is often possible to restore the functionality of contaminated probes with cleaning. If the contaminant is known, the tube should be filled with a fluid that is known to be a solvent to that contaminant. As an example, ether is often effective in removing residues of some oils. Commercial carburetor cleaners are very powerful solvents and are highly effective against some contaminants.

After cleaning with solvents, the gauge tube should be completely dried or flushed with a volatile solvent to assure that it is dry prior to reinstalling it. If this is not done, contamination of the system may result.

B. Maintenance

Your vacuum instrument should give you many years of trouble free service. There are no regularly scheduled maintenance intervals. If consistent accuracy is required, it is recommended that the gauge, tube, cable and power supply be returned for a yearly calibration check.

C. Factory Repair and Calibration

The vacuum gauge assembly is designed to provide years of trouble free service, and the liberal internal use of plug-in components make it easily repairable.

D. Notes on Calibration

The instrument is calibrated in nitrogen, which has thermal properties virtually identical to air. Other gasses will affect the readings by an amount proportional to the thermal conductivity of the gases. In most cases, the gases present in a vacuum system will be air, nitrogen, or oxygen, and no appreciable errors will occur.

Certain other gases, however, have thermal conductivity significantly greater than air and will cause the instrument to read higher than the actual amount of pressure. Examples of such gases are water vapor, fluorocarbon refrigerants, and acetone. Conversely, other gasses have thermal conductivity significantly lower than air and will cause the instrument to read lower than actual pressure. Examples of such gases include helium, oxygen and to a lesser extent, CO₂.

When interpreting readings using gasses other than air, it should be borne in mind that the Ruggedized Portable Gauge reads Torr, which is a measure of absolute pressure that is the opposite of vacuum. Thus, a lower numerical reading actually is a higher level of vacuum.

XII. Instrument Accuracy

.001 to .010 Torr	+/- .002 Torr
.010 to 10 Torr	+/- 20% of reading
10 to 300 Torr	In range (10, 300 Torr), increasing pressure results in increasing value
300 to 800 Torr	+/- 20% of reading

Instrument Accuracy with random tube

Assume replacement Tube is the same type from the same manufacturer, **MID** and **VAC** set to zero, **ATM** rough calibrated to 760 when tube exposed to ATM

.001 to .030 Torr	+/- .015 Torr
.030 to 1.00 Torr	+/- 30% of reading
1.00 to 300 Torr	In range (1, 300 Torr), increasing pressure results in increasing value
300 to 800Torr	+/- 30%of reading

XIII. Specifications

Time to resolve	2 seconds to decade, 20 seconds to full accuracy
Input Voltage	4 AA Alkaline
Maintenance Interval	1-10 years depending on use
Overall Dimensions, front panel	6.0 in high, 3.5 in wide, 1.25 inches deep
Ambient Operating range	40°F to 120°F
Battery Life	70 Hours running
Measurement Media	Clean Dry Air or Nitrogen
Certifications, controller display	CE Planned

XIV. Warranty

Duniway products are warranted to be free of defects in material and workmanship for a period of one year from the date of shipment. At our option, we will repair or replace products which prove to be defective during the warranty period. Liability under this warranty is limited to repair or replacement of the defective items. Shipping damage is excluded from the scope of this warranty. Gauge tubes of all types are excluded from this warranty.

If this product is returned to Duniway Stockroom for warranty service, Buyer will prepay shipping charges and will pay all duties and taxes for products returned to Duniway Stockroom. Duniway Stockroom will pay for return of products to Buyer, except for products returned to a Buyer from a country other than the United States.

LIMITATION OF WARRANTY: The foregoing warranty does not apply to the defects resulting from:

1. Improper or inadequate maintenance by Buyer;
2. Buyer-supplied interfacing;
3. Unauthorized modification or misuse;
4. Operation outside of the environmental specifications of the product; or
5. Improper site preparation and maintenance.

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