

PneuView®3 Advanced Simulation Software Manual



4717 Talon Court SE
Grand Rapids, MI 49512 USA
(800) 530-9939 or (616) 554-9696
Fax: (616) 554-3067
mii@michiganinstruments.com
www.michiganinstruments.com

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The Concept and Scope of a PneuView3 Project

The PneuView® System is a tool that can be used to diagnose and troubleshoot device malfunctions and to perform periodic performance testing on ventilators. PneuView is also recognized as an invaluable tool in the classroom. PneuView projects are customizable by nature, and must first be set up to achieve the goals of the user. While the default settings are a good starting point, they may not be appropriate for the majority of the applications of the TTL. The following are settings that should be selected and verified by the user prior to using the device:

- Lung Compliance
- Airway Resistance
- Barometric Pressure

The PneuView Software System is designed to record and analyze the data stream as it is acquired in real-time through the use of a PneuView Project. Essentially, the PneuView Project manages all real-time data, allowing the user to review multiple parameters, graphs, and breath trends.

Standard Parameter Notation Used In PneuView3*

Tidal Volume: V_t (mL)

Total Flow: F_t (mL/s)

Inspiratory to Expiratory Ratio: I:E

Airway Pressure: P_a (cmH₂O)

Lung Pressure: P_l (cmH₂O)

Peak Airway Pressure: PAP (cmH₂O)

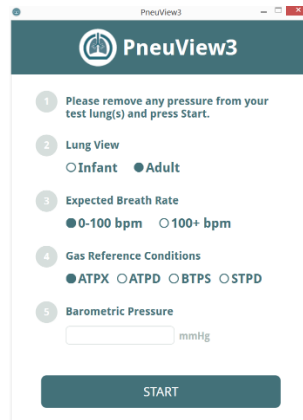
Breath Rate: bpm

*A full list of measured parameters, including nomenclature and units, is available in the glossary section.

Setting Up a PneuView3 Project

NOTE: Before launching PV3, ensure there is no pressure applied to the TTL and it is powered on and connected to the computer.

When PV3 is launched the project setup screen will be displayed. This window will allow the user to tune the TTL and PV3 system to its' physical environment. Please note that zeroing the system is a part of this process. For this reason, ensure that the system is vented to atmosphere before clicking the *Start* button.



The following fields must be specified before launching a PneuView project:

Set Lung View—Selects active lung chamber(s) for the project. If you are using a single lung TTL this field will be disabled.

Expected Breath Rate—Select the anticipated breaths per minute (bpm) to be delivered.

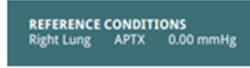
Gas Reference Conditions—Selects reference values. **Ambient Temperature and Pressure, Relative (X) humidity (ATPX, set pressure, measured temperature, relative humidity)** **Ambient Temperature and Pressure, Dry (ATPD, set pressure, measured temperature, relative humidity)** **Body Temperature and Pressure, Saturated (BTPS, 760mmHg, 37°C, 100% humidity)** **Standard Temperature and Pressure, Dry (STPD 760mmHg, 21°C, 0% humidity)** may be selected.

Barometric Pressure—Set reference barometric pressure. This will help to fine-tune the pressure, volume and flow readings displayed by the lung. Please note that this reference does not affect the oxygen sensor reading.

Once you have made the desired selections, click the *Start* button and the PV3 project window will open.

Real-Time Data Acquisition and Analysis

Project Reference Statement



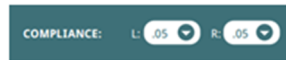
Reference conditions entered into the project setup screen are displayed in the upper left corner of the PneuView3 Project screen. Lung selection, reference value and barometric pressure will be displayed here.

Trend Test Tool



Trend testing is a feature of PneuView3 that can be accessed through the project screen. The trend test tool is located in the center of the top bar of the screen. For more information on the trend test tool refer to the “Trend Testing” setting below.

Lung Compliance Tool



In order to ensure that accurate data is displayed the compliance of the lung(s) in use must be set. The drop-down menu(s) in the upper right of the PneuView3 project screen are used to set lung compliance value(s). (The .015/.0015 settings are not supported in PV3 at this time.)

Flow Measurement Tool



Flow in the Training and Test Lung is displayed by the flow measurement tool, pictured above. The graph represents total flow (L/m) as a function of time (s). Peak inspiratory flow is shown in the window to the right of the graph (L/m). This represents an average of the previous 3 peak inspiratory flow values logged by the PneuView3 software.

Pressure Measurement Tool



Pressure in the Training and Test Lung is displayed by the pressure measurement tool, pictured above. The graph represents Proximal Pressure (cmH₂O) as a function of time. Positive End Expiratory Pressure (PEEP) and Peak Airway Pressure (PAP) are shown in the window to the

right of the graph (cmH₂O). These values represent an average of the last 3 corresponding data points taken by the PneuView3 software.

Volume Measurement Tool



Volume in the Training and Test Lung is displayed by the volume measurement tool, pictured above. The graph represents Total Volume (mL) as a function of time. Inspiratory and Expiratory Tidal Volumes (mL) along with Minute Volume (L) are shown in the window to the right of the graph. These values represent an average of the last 3 corresponding data points taken by the PneuView3 software.

Breath Ratio Tool



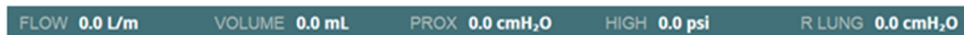
Inspiratory, Expiratory (I:E) ratio, inspiratory time and expiratory time are charted by the breath ratio tool, found in the lower left corner of the screen.

Ambient Condition Tool



The Ambient Condition Tool, located in the lower right side of the PneuView3 project screen, charts oxygen concentration and lung temperature (°C).

Miscellaneous Measurement Tool



Parameters tracked by the graphs in the flow, volume, and pressure measurement tools (Total Flow, Total Volume and Proximal Pressure) are displayed numerically in real time in the Miscellaneous Measurement Tool at the bottom of the screen. Pressure data from the High Pressure Port (psi) and the internal lung sensors (cmH₂O) are also included in this tool.

Trend Testing and Data Interpretation

Trend testing in PneuView3 can be initiated by clicking on the trend test tool at the top of the screen. After the “Start” button is clicked, the trend test setup window will open.

Type	Target	%	+/-
<input checked="" type="checkbox"/> Tidal Volume	20	5	20
<input checked="" type="checkbox"/> Peak Flow	15	5	5
<input checked="" type="checkbox"/> Peak Proximal	9	5	1
<input checked="" type="checkbox"/> I:E Ratio	1.25	5	0.25
<input checked="" type="checkbox"/> Breath Rate	59	5	1
<input checked="" type="checkbox"/> High Pressure	0	5	5
<input checked="" type="checkbox"/> Insp Time	0.6	5	0.1
<input checked="" type="checkbox"/> Exp Time	0.4	5	0.1
<input checked="" type="checkbox"/> PEEP	1	5	1
<input checked="" type="checkbox"/> Minute Volume	1	5	1

Test duration, sample rate, measured parameters, target values and tolerances are set here. Settings in the fields displayed will affect the test in the following ways:

Directory—shows the directory in which the test data will be stored. Default location is C:\users\\documents. The target area can be changed by clicking on the “Choose Output Directory” button.

Test Name—displays the title that will be assigned to the output data.

Type—displays all of the measured parameters that PneuView3 is capable of analyzing during a trend test. A checkmark in the box next to a parameter indicates that the associated parameter will be included in the test data. Parameters can be selectively omitted by un-checking these boxes.

Target—represents the target value of each parameter during the trend test. Default values in these fields will represent the average of the last three breaths delivered to the lung prior to launching the trend test.

%—represents the percentage of acceptable deviation from the target values during the test. Can be edited separately from the “+/-” category.

+/- —numerical representation of acceptable deviation from the target values. Can be edited separately from the “%” category.

NOTE: When both a “%” and a “+/-” value are entered, the software will use the value that is the most forgiving only when determining a “pass/fail” condition.

Duration—displays the length of the test. Minimum: 1 minute. Maximum: 1,000 hours.

Sample Rate—the rate at which data points will be acquired during the test.

Start—clicking this button will initiate a trend test with the selected settings.

Cancel—clicking this button will close the trend test setup window and erase any settings that have been entered.

Trend test results will be saved in the target directory as a .csv text file. Please refer to the data analysis section for information on how to process the results. For more information on specific trend parameters please refer to the glossary.

Data Interpretation and Analysis

Upon completion of a trend test, the data taken will be stored as a .csv text file in the folder indicated by the trend test setup window (set by clicking on the “Select Output Directory”). Data analysis can be performed by opening the .csv text file created by a trend test. These files are most easily interpreted via Microsoft Excel or a similar program. When opened, a data table will be displayed in which the 10 parameters charted by a trend test appear across 40 columns. Each parameter is represented by four consecutive columns displaying minimum, maximum, average and tolerance values, respectively. If any of the first three values fall outside of the tolerance that was selected during setup, then the tolerance column will read “FALSE,” otherwise “TRUE” will be displayed. Rows on the data table represent data samples in the order that they were taken. Columns are labeled with the name of the parameter that they represent and appear in the following order:

Inspiratory tidal volume field (Columns A-D)

Peak flow rate field (Columns E-H)

Peak proximal pressure field (Columns I-L)

Inspiratory/expiratory ratio field (Columns M-P)

Breath rate field (Columns Q-T)

High pressure value field (Columns U-X)

Inspiratory time field (Columns Y-AB)

Expiratory time field (Columns AC-AF)

Positive end expiratory pressure field (Columns AG-AJ)

Minute volume field (Columns AK-AN)

Limitation of Liability

Michigan Instruments, Inc. warrants that the PneuView® software will conform to the published specifications and documentation, provided that it is used on a computer system for which it is designed. Michigan Instruments also warrants that the supplied distribution disks and documentation are free from defects in materials and workmanship for 90 days after delivery. Michigan Instruments will replace defective disks or documentation at no charge, provided you return the item to Michigan Instruments within 90 days of delivery.

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Glossary

Proximal Pressure (pProx): Real-time parameter; pressure measured at the point just before gas delivered from the ventilator under test enters the Airway Resistor; analogous to "Airway Pressure" or "Patient Proximal Pressure" indicated by some ventilators. Clinically equivalent to the pressure measured at the point where gas delivered by the ventilator enters the patient airway (e.g., endotracheal tube, mask, etc.). Sampled by the PneuView system at 10ms intervals; range is -20.0 to +120.0 cmH₂O.

Lung Pressure (pLung): Real-time parameter; pressure measured within the test lung bellows chamber; analogous to "Intrapulmonary Pressure" or "Alveolar Pressure. Clinically equivalent to the average intra-alveolar pressure if such could be measured throughout the lung. Sampled by the PneuView system at 10ms intervals; range is -20.0 to +120.0 cmH₂O.

High Pressure (pHigh): Real-time parameter; pressure measured at the external DISS port; intended for monitoring external gas sources, such as the ventilator oxygen, air or other gas supply. Sampled by the PneuView system at 10ms intervals; range is 0.0 to +100.0 psi.

Peak Airway Pressure: Breath parameter; arithmetic maximum of all Proximal Pressure measurements recorded during that last completed inspiratory phase; clinically equivalent to the parameter of the parameter of the same name. Calculated by the PneuView system following the end of each inspiratory phase; range is -20.0 to +120.0 cmH₂O.

Baseline Pressure: Breath parameter; average Proximal Pressure measured just prior to the beginning of the last inspiratory phase. Calculated by the PneuView system following the start of each inspiratory phase; range is -20.0 to +120.0 cmH₂O.

Peak Intrapulmonary Pressure: Breath parameter; arithmetic maximum of all Lung Pressure measurements recorded during that last completed inspiratory phase; clinically equivalent to the parameter of the parameter of the same name. Calculated by the PneuView system following the end of each inspiratory phase; range is -20.0 to +120.0 cmH₂O.

Peak Inspiratory Flow: Breath parameter; arithmetic maximum of all Flow Rate measurements recorded during that last completed inspiratory phase; clinically equivalent to the parameter of the parameter of the same name. Calculated by the PneuView system following the end of each inspiratory phase; range is -120.0 to +120.0 L/min.

Tidal Volume: Breath parameter; total Volume received into the lung during the last inspiratory phase; clinically equivalent to the parameter of the same name. Calculated by the PneuView system following the end of each inspiratory phase; range is 0 to 2.0 L (per lung).

Minute Volume: Breath parameter; product of Tidal Volume and Breath Rate calculated during the last inspiratory phase; clinically equivalent to the parameter of the same name. Calculated by

the PneuView system following the end of each inspiratory phase; range is 0 to 120.0 L (per lung).

Peak Expiratory Flow: Breath parameter; arithmetic maximum of all Flow Rate measurements recorded during that last completed expiratory phase; clinically equivalent to the parameter of the same name. Calculated by the PneuView system following the end of each expiratory phase; range is -120.0 to +120.0 L/min.

Inspiratory Time: Breath parameter; time measured from onset of the Inspiratory Phase (positive gas flow into the lung) until the initiation of the Expiratory Phase (gas outflow from the lung); clinically equivalent to the parameter of the same name. The Inspiratory Phase includes the Inspiratory Hold Phase, and Inspiratory Hold Time is part of the reported Inspiratory Time. Calculated by the PneuView system at the end of each inspiratory phase. Range is 0.0 to 60.0 s.

Expiratory Time: Breath parameter; time measured from onset of the Expiratory Phase (gas outflow from the lung) until the initiation of the Inspiratory Phase (positive gas flow into the lung); clinically equivalent to the parameter of the same name. Calculated by the PneuView system at the end of each expiratory phase. Range is 0.0 to 60.0 s.

Breath Rate: Breath parameter; number of total breath phase sets per minute; clinically equivalent to the parameter of the same name. Calculated by the PneuView system at the end of each Inspiratory and Expiratory phase. Range is 0 to 200 breaths per minute.

I:E Ratio: Breath parameter; arithmetic ratio of total Inspiratory time to Expiratory Time. Clinically equivalent to the parameter of the same name. Calculated by the PneuView system at the end of each Inspiratory and Expiratory phase.