BC Biomedical

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BENCHTOP FLOW ANALYZER

PFC-3000 SERIES

USER MANUAL

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BC BIOMEDICAL
BC GROUP INTERNATIONAL, INC.
3081 ELM POINT INDUSTRIAL DRIVE
ST. CHARLES, MO 63301
USA

1-800-242-8428
1-314-638-3800

www.bcgroupintl.com
sales@bcgroupintl.com

1 Content

2 Preface

Application

This documentation applies to the products described as:

- ***FlowAnalyzer™ PFC-3000A, FlowAnalyzer™ PFC-3000V, FlowAnalyzer™ PFC-3000L***
- ***MultiGasAnalyzer™ MGA-3050***
- ***FlowLab™***

You will find the designation ***FlowAnalyzer™*** on the nameplate on the back of the device.

In this user manual, the designation ***FlowAnalyzer™*** includes the ***FlowAnalyzer™ PFC-3000A, FlowAnalyzer™ PFC-3000V*** and the ***FlowAnalyzer™ PFC-3000L***.

Software and Firmware versions

This documentation applies to the following versions:

- ***FlowLab™* Software** **Version 4.2.1**
- ***FlowAnalyzer™* Firmware** **Version 4.2.9**

When using older or newer versions small differences to this manual may appear.

Key to symbols used in this manual

Keys, ***FlowAnalyzer™*** labels and information in the display	Keys, such as ***Power***, labels, such as ***USB***, and information in the display, such as ***Changing the settings***, are shown in bold, italic type.
References to pages and chapters	The symbol (> XY) is used for references to pages and chapters (> 5.1.6 Physical Data).

3 Intended Use

The ***FlowAnalyzer™*** is a compact, mobile and easy-to-use measuring device.

The ***FlowAnalyzer™*** carries out all the following measurements:

- Low flow (-20...20 l/min)
- High flow (-300…300 l/min)
- Volume
- Differential pressure
- High pressure
- Atmospheric pressure
- Oxygen
- Temperature
- Humidity
- Dew point

It can also measure a variety of respiratory parameters:

- Inspiration volume, expiration volume
- Rate of respiration
- I:E
- Inspiration time, expiration time
- Ppeak
- Pmean
- Pplateau
- PEEP
- PF Insp (Peak flow inspiratory)
- PF Exp (Peak flow expiratory)
- Ti/Ttotal
- Cstat
- Delta P

The ***FlowAnalyzer™*** has been designed for mobile use. In the event of power failure the device can be operated from a built-in battery.

The ***FlowAnalyzer™*** is a measuring device for testing and calibrating ventilators. The ***FlowAnalyzer™*** should not be used for patient monitoring.

The ***FlowAnalyzer™*** must not be connected to a ventilator which is being used by a patient.

4 Safety Instructions

4.1 Symbols for Danger, Warnings and Notes

This User Manual uses the symbols below to draw your specific attention to the remaining dangers associated with proper use, and to emphasize important technical requirements.

Information or directions / warnings to prevent any sort of damage / risk.

4.2 Personnel

The ***FlowAnalyzer™*** may only be operated or worked on by personnel with suitable technical training and appropriate experience.

4.3 Responsibilities and Guarantees

The manufacturer assumes no responsibility or guarantee, and exonerates himself accordingly from liability claims, where the operator or any third party has:

- Used the device improperly
- Disregarded technical data
- Tampered with the device in any way (modifications, changes, etc.)
- Operated the device using accessories that are not listed in the associated product documentation.

Although this device features a high standard of quality and safety and has been built and tested according to the current state of the art, improper usage or misuse can result in injuries with serious consequences.

Therefore please read this user manual carefully and keep this documentation within reach of the device.

5 Technical Data

5.1 Measurement Categories

5.1.1 Analyzer Values[1]	Low flow	Range Accuracy	± 20 sl/min ± 1.75% of reading or ± 0.04 sl/min
	High flow	Range Accuracy	± 300 sl/min ± 1.75% of reading or ± 0.1 sl/min
	Volume	Range Accuracy	± 100 sl ± 2% of reading or ± 0.02 sl (High flow) ± 0.01 sl (Low flow)
	Pressure (in High flow)	Range Accuracy	0…150 mbar ± 0.75% of reading or ± 0.1 mbar
	Differential pressure	Range Accuracy	± 150 mbar ± 0.75% of reading or ± 0.1 mbar
	High pressure	Range Accuracy	0...10 bar ± 1% of reading or ± 10 mbar
	Atmospheric pressure	Range Accuracy	0...1150 mbar ± 1% of reading or ± 5 mbar
	Oxygen	Range Accuracy	0...100 % Vol ± 1% Vol
	Humidity	Range Accuracy	0...100 % RH, Non-condensing ± 3% RH
	Temperature	Range Accuracy	0...50 °C ± 1.75% of reading or ± 0.5 °C
	Dew point	Range Accuracy	-10...50 °C ± 2% of reading or ± 1 °C
	Additional pressure sensors	Find details in chapter 6.3.6 Low pressure (PFC-3000L) and 6.3.7 Pressure sensor ± 1 bar *(PFC-3000V)*.	

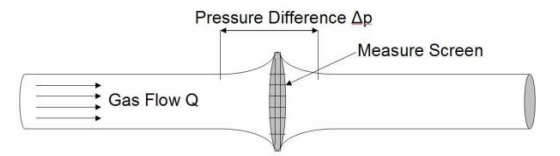
[1] Standard liter per minute (calculated using STP conditions of 21°C and 1013 mbar)

5.1.2 Respiratory Parameters

Vti, Vte	Breath volume of inspiration and expiration	Range Accuracy	± 10 sl (High flow) ± 1.75% or ± 0.0002 sl (>6 sl/min) (Low flow) ± 1.75% or ± 0.0001 sl (>2.4 sl/min)
Vi, Ve	Minute volume of inspiration and expiration	Range Accuracy	0...300 sl/min (High flow) ± 2.5% or 0.02 sl/min (Low flow) ± 2.5% or 0.01 sl/min
Ti, Te	Inspiration and expiration times	Range Accuracy	0.05...60 s ± 0.02 s
Ti/Ttotal	Ratio Inspiration time : Breath cycle time	Range Accuracy	0...100% ± 5%
Ppeak	Maximum pressure	Range Accuracy	0...150 mbar ± 0.75% or ± 0.1 mbar
Pmean	Mean pressure	Range Accuracy	0...150 mbar ± 0.75% or ± 0.1 mbar
I:E	Respiration time ratio	Range Accuracy	1:300...300:1 ± 2.5%
PEEP	Positive End Expiratory Pressure	Range Accuracy	0...150 mbar ± 0.75% or ± 0.1 mbar
Rate	Rate of respiration	Range Accuracy	1...1000 bpm ± 2.5% or ± 1 bpm
PF Insp.	Maximum flow of inspiration	Range Accuracy	± 300 sl/min ± 1.75% or ± 0.1 sl/min
PF Exp.	Maximum flow of expiration	Range Accuracy	± 300 sl/min ± 1.75% or ± 0.1 sl/min
Cstat	Static Compliance	Range Accuracy	0...1000 ml/mbar ± 3% or ± 1 ml/mbar
Pplateau	Plateau Pressure	Range Accuracy	0...150 mbar ± 0.75% or ± 0.1 mbar
Delta P	Amplitude Pressure (Ppeak – PEEP)	Range Accuracy	0...150 mbar ± 0.75% or ± 0.1 mbar

5.1.3 Principle of Operation for Flow Measurement

The Flow is measured over a differential pressure measurement in the flow channel. A screen is used as the restrictor.



$$\Delta p = c_1 \cdot \eta \cdot Q + c_2 \cdot \rho \cdot Q^2$$

η: dynamic viscosity of gas [Pa s]

ρ: density of gas [kg / m3]

c1, c2: device specific constants (channel geometry)

Dynamic Viscosity
- The viscosity of a medium is its resistance to shear or flow
- The viscosity is strongly temperature dependent
- Small dependency on humidity and pressure

Density
- The density is a measure of the medium's mass per unit of volume
- The density is strongly temperature and pressure dependent

The dependence on the ambient conditions is the reason why the flow is sometimes transferred to standard conditions (>5.2 Standard Conditions for Flow Measurement).

5.1.4	Special Functions	Automatic battery operation in event of power failure.	
5.1.5	Communication Interfaces	USB RS-232 port for FW download, remote control and connection of optional ***MultiGasAnalyzer™ MGA-3050*** Trigger input (digital) for external trigger	
5.1.6	Physical Data	Weight: Dimensions (L x W x H): Gas types:	< 8.5 Lbs (3.8 kg) 8.67 x 9.84 x 4.72 Inches (220 x 250 x 120 mm) Air, O_2, N_2O, He, N_2, CO_2 and Mixed: Air/O_2, N_2O/O_2, He/O_2
5.1.7	Calibration by User	Offset calibration of pressure sensors Calibration of oxygen sensor	
5.1.8	Operational Data	Temperature: Humidity: Air pressure: Storage and transport conditions:	15...40 °C (59...104 °F) 10%...90% RH, non-condensing 700...1060 mbar -10...60 °C (14...140 °F) at 5...95% RH
5.1.9	Extras	- ***FlowLab™*** Software - ***MultiGasAnalyzer™ MGA-3050***	

5.2 Standard Conditions for Flow Measurement

The FlowAnalyzer calculates the internal flow and volume measurements with the terms of the selected gas standard. The FlowAnalyzer supports the following gas standards:

Gas Standard		Temperature	Pressure	Relative Humidity
Ambient Temperature and Pressure	ATP	Current gas temperature	Current ambient pressure	Current gas humidity
Ambient Temperature and Pressure Dry	ATPD	Current gas temperature	Current ambient pressure	0%
Ambient Temperature and Pressure Saturated	ATPS	Current gas temperature	Current ambient pressure	100%
Ambient Pressure at 21°C	AP21	21.0 °C (70 °F)	Current ambient pressure	Current gas humidity
Standard Conditions USA	STP	21.1 °C (70 °F)	1013.25 mbar (760 mmHg)	0%
Standard Conditions USA Humid	STPH	21.1 °C (70 °F)	1013.25 mbar (760 mmHg)	Current gas humidity
Body Temperature and Pressure Saturated	BTPS	37 °C (99 °F)	Current ambient pressure	100%
Body Temperature and Pressure Dry	BTPD	37 °C (99 °F)	Current ambient pressure	0%
Standard Conditions according to DIN 1343	0/1013	0 °C (32 °F)	1013.25 mbar (760 mmHg)	0%
Standard Conditions according to ISO 1-1975 (DIN 102)	20/981	20 °C (68 °F)	981 mbar (736 mmHg)	0%
API Standard Conditions	15/1013	15 °C (60 °F)	1013.25 mbar (14.7 psia)	0%
Cummings Standard	25/991	25 °C (77 °F)	991 mbar (500 ft. high)	0%
20 °C / 1013 mbar	20/1013	20 °C (68 °F)	1013.25 mbar (760 mmHg)	0%

In this user manual the unit **sl/min** is based on ambient conditions of 0 °C and 1013 mbar (DIN 1343). Please refer to Appendix B: Values and Units where you also can find conversion factors for the units.

5.3 Power Supply

Input voltage of power pack	100-240 VAC, 50-60 Hz
Supply voltage	15 V DC
Power consumption	25 VA (W)

5.4 Battery Mode

Running time in battery mode	3 h
Running time in battery mode with the ***MultiGasAnalyzer™***	2 h
Charging the battery	A complete charge takes 8 h. The usable battery life will be extended if the battery is used until the request for recharge and then charged for 8 h.

The instrument provides audible and visual alarm as soon as the battery has to be recharged. Do not keep the battery in discharged mode!
Attention: A total discharge may destroy the battery!

5.5 Compliance and Approvals

CE

- IEC 1010-1 (safety)
- EN61326-1 (EMC)

C SP US

- CAN/CSA-C22.2 No. 0-M91 (General)
- CAN/CSA-C22.2 No. 1010.1-92 (Safety)
- CAN/CSA-C22.2 No. 1010.1 B-97 (Safety)
- UL. Std No. 61010B-1. 1st Ed. (General)

The instrument is classified in Installation category II.

The instrument is assigned to Pollution degree 2.

The instrument is designed for indoor use only.

5.6 Device Labels and Symbols

The following labels and symbols can be found on the ***FlowAnalyzer™ :***

RS232	RS232 interface (for servicing)
USB	USB interface (for PC communication)
SN: xxxx	Serial number
	Warning: observe accompanying documents.
	Date of production Month - Year
	Ground

5.7 Minimum PC Requirements

Intel® Pentium® III 800 MHz

(P4 1200 MHz recommended)

Microsoft® Windows® 98, Me, 2000, XP

Microsoft® Internet Explorer 5.01 or above

128 MB RAM (256 MB recommended)

160 MB hard disc space (full installation)

CD ROM drive

Screen 800 x 600 (1024 x 768 recommended)

6 Preparing for Use

6.1 Individual Supplied Parts

Basic unit:

FlowAnalyzer™

Power pack

USB cable

User manual and calibration certificate

FlowLab™ PC software

Filter

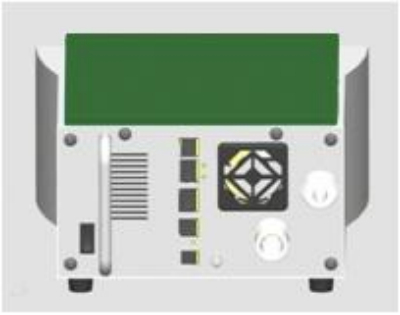
FlowAnalyzer™ Adapter Set

6.2 Power Supply

Power is connected to the back of the ***FlowAnalyzer™ .***

The main power switch is used to switch the instrument on and off.

A LED marked with ***Charging*** lights up when the battery is being charged. This also works when the device is off.



6.2.1 Supply Voltage

The mains voltage for the ***power pack supplied*** is 100...240 V AC at 50...60 Hz.

The ***FlowAnalyzer™*** may only be operated with the original power pack supplied!

For protection against interference from electromagnetic fields and static electricity, the device must be grounded using the pins provided.

Before you switch on the device, check that the operating voltage of the ***power pack*** complies with the local mains voltage.

Details can be found on the nameplate on the back of the ***power pack***.

6.3 Mechanical Connections

6.3.1 Protection Filter

In order to protect the instrument from contaminations with particles of the air it is important to use the filter, which is delivered with each instrument. The filter has to be used on the High flow as well as on the Low flow channel.

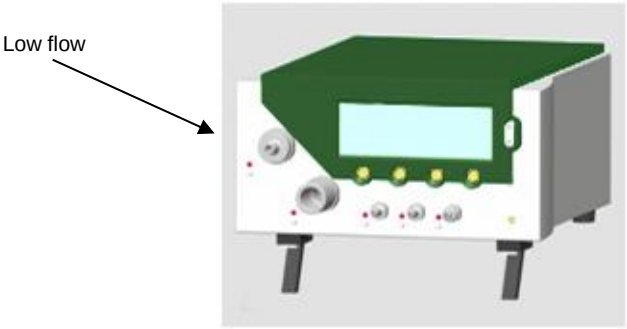
Particles in the air may clog the measuring system and result in inaccurate measuring results. The Filter must be checked on a regular basis.

6.3.2 *FlowAnalyzer™* Adapter Set

The ***FlowAnalyzer™*** Adapter Set included assists in connecting various test objects to the ***FlowAnalyzer™***. A minimal amount of dead space as well as minimal differences in the Flow stream assist in assuring highly accurate measurements. When using the Low flow connection for measuring respiratory parameters, the positive interface of the differential pressure sensor is used for the pressure measurement. The T-Piece included with the connection tube connects the corresponding interfaces.

6.3.3 Low Flow[2]

The ***Low flow*** connection is used to measure small flow rates. In order to calculate respiratory parameters using this measurement channel, the trigger must be set to “infant”. Thereby, the positive interface from the differential pressure sensor will automatically be used as the pressure sensor. The T-Piece with the connection tube can be used to connect these two interfaces.



Range:	± 20 sl/min
Accuracy:	± 1.75% of reading or 0.04 sl/min

There are no additional sensors in the low flow channel to measure temperature, humidity, or O_2 concentration which have an impact on flow measurement.

To achieve very accurate measurements it helps if the back end of the low flow channel is connected to the high flow channel. On this way the additional values can be measured.

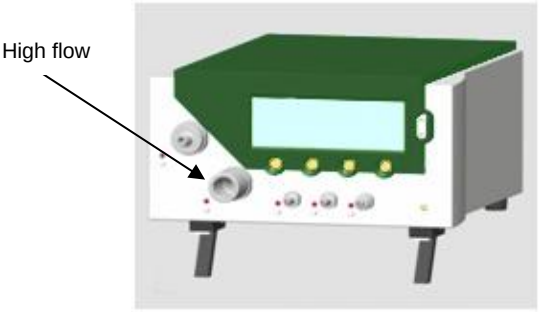
For Flows higher than 20 sl/min the measurement is not accurate anymore.

[2] Standard liter per minute (calculated using STP conditions of 21°C and 1013 mbar)

6.3.4 High Flow[3]

The ***High flow*** connection can be used for the following bi-directional measurements:

- High flow rates (± 300 sl/min)
- Volume
- Temperature
- Humidity
- Oxygen
- Pressure in the channel



High flow:	Range:	± 300 sl/min
	Accuracy:	± 1.75% of reading or ± 0.1 sl/min
Volume:	Range:	0...10 sl
	Accuracy:	± 2% of reading or ± 0.02 sl
Temperature:	Range:	0...50 °C (32...122 °F)
	Accuracy:	± 1.75% of reading or ± 0.5 °C
Humidity:	Range:	0...100% not condensing
	Accuracy:	± 3% RH
Oxygen:	Range:	0...100 %
	Accuracy:	± 1% O_2
Pressure	Range:	0...150 mbar
	Accuracy:	± 0.75% of reading or ± 0.1 mbar

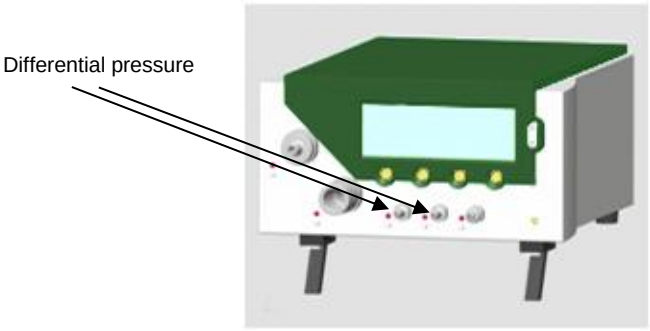
When working with higher humidity it is important that there is no condensation inside the instrument. **Water can destroy the sensors!**

Pressures higher than 500 mbar will destroy the sensors!

[3] Standard liter per minute (calculated using STP conditions of 21°C and 1013 mbar)

6.3.5 Differential Pressure

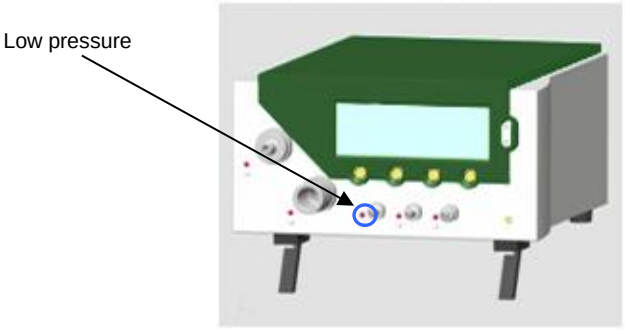
The ***Differential pressure*** connections can be used to measure differential pressure.



Range:	± 150 mbar
Accuracy:	± 0.75% of reading or ± 0.1 mbar

6.3.6 Low pressure *(PFC-3000L)*

There is an additional low pressure sensor for the ***PFC-3000L***. The sensor is connected to the specified connector and is marked with a blue ring.

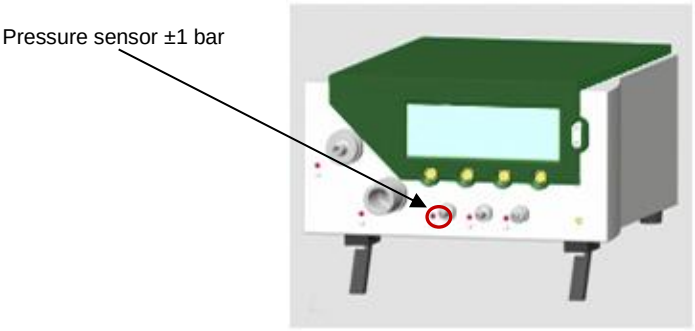


Range:	0...5 mbar
Accuracy:	± 1% of reading or ± 0.01 mbar

When using one of the pressure options (low P or ± 1bar), the sensor (± 150 mbar) will be connected to the remaining connector where as the second port of the sensor is measuring against ambient. The measurement range remains the same.

6.3.7 Pressure sensor ± 1 bar *(PFC-3000V)*

There is an additional pressure sensor ± 1 bar for the ***PFC-3000V***. The sensor is connected to the specified connector and is marked with a red ring.



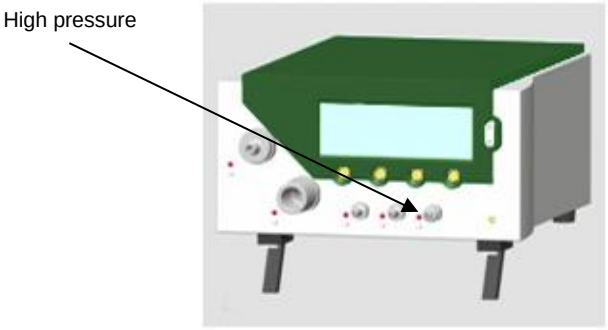
Range:	± 1000 mbar
Accuracy:	± 0.5% of reading or ± 2 mbar

When using one of the pressure options (low P or ± 1bar), the sensor (± 150 mbar) will be connected to the remaining connector where as the second port of the sensor is measuring against ambient. The measurement range remains the same.

6.3.8 High Pressure

The ***High pressure*** connection can be used to measure pressures greater than 150 mbar.

If you prefer for this connection a DISS O_2 Connection, there is an appropriate adapter available.



Range:	0...10 bar
Accuracy:	± 1% of reading or ± 10 mbar

When measuring below 150 mbar it is recommended to use the Differential Pressure port ± 150 mbar since the accuracy is up to 100 times higher.

Pressures higher than 15 bar will destroy the sensor!

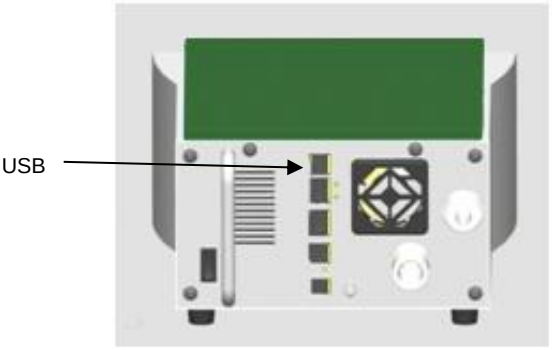
6.4 Electrical Interfaces

6.4.1 USB

The USB interface is used to connect the ***FlowAnalyzer™*** to the PC. The connection is located on the back of the device.

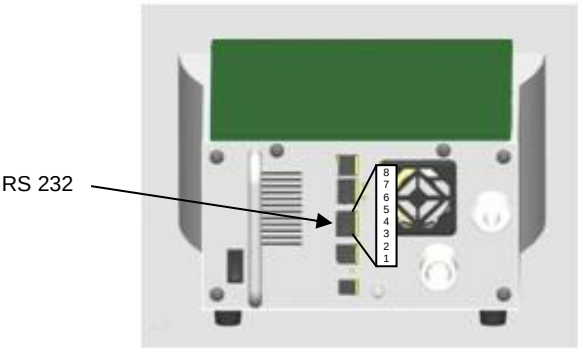
If ***FlowLab™*** software was supplied with the device, the recorded values can be graphically displayed on the computer.

If your device does not have this software, the USB connection will be blocked. It can be released at any time with a clearance code (> 8.2 USB Communication).



6.4.2 RS 232

The RS232 interface is used for servicing (firmware download), for the connection of the ***MultgasAnalyzer™ MGA-3050*** as well as for remote control of the unit and is located on the back of the ***FlowAnalyzer™.***



The connection to the RS 232 port has to be established over the special RS 232 interface cable.

If the instrument has to be remote controlled e.g. through a specific software package you can ask your authorized dealer for a detailed description of the protocol.

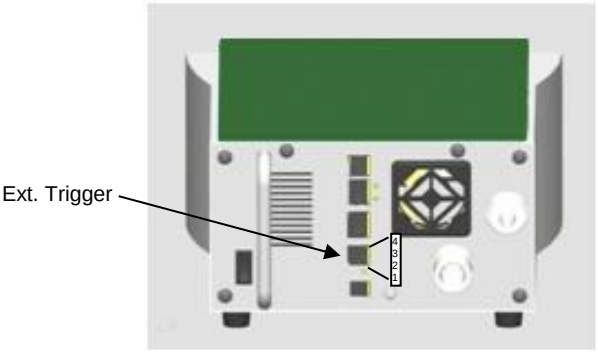
FlowAnalyzer™ pin assignment (RJ-45 connector):

Pin 1	+5 V
Pin 4,5	GND
Pin 7	TxD
Pin 8	RxD
Pin 2,3,6	No connection

6.4.3 External Trigger

The **external trigger** interface is used to trigger measurement of volume. The input is decoupled.

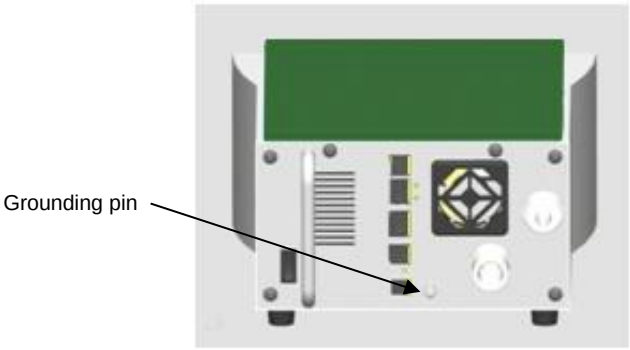
Please use a 4 pole FCC plug of the type RJ-10 to connect.



Assignment	1,2	5-24 V DC
	3,4	GND

6.4.4 Grounding

To protect the device from interference by electromagnetic fields, as well as prevent internal static electricity build-up, it must be grounded using this connection.



7 Operation

7.1 Switching the Device On and Off

Check that all cables and hoses are connected correctly, and check compliance with technical data (>6 Preparing for Use).

The device can be switched on and off with the on/off switch on the back.

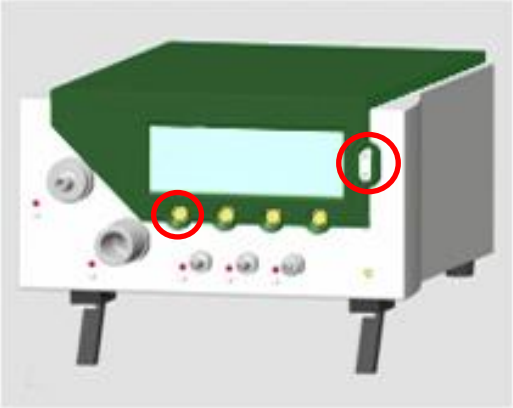
7.2 The Start Screen

When the ***FlowAnalyzer***™ is switched on, a welcome screen appears. Three seconds later the numerical readings are displayed.

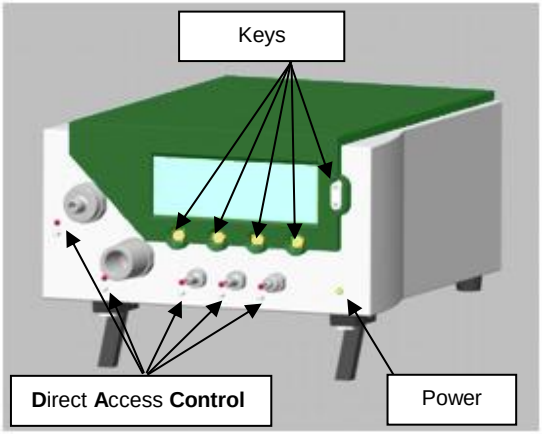
If you wish to change the displayed language please use the language selector (>7.16 Setting the Language).

7.3 Adjusting the Contrast

The display quality depends on the angle of viewing. You may have to adjust the contrast to suit the angle of viewing to get the best display quality.
You adjust the contrast by simultaneously pressing the two highlighted keys.



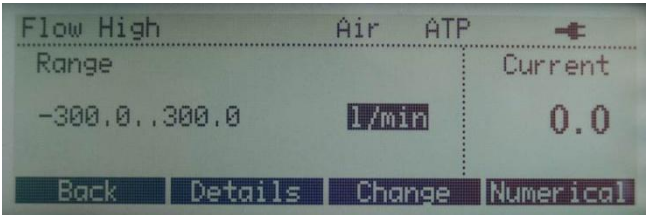
7.4 Description of Operating Controls



7.5 Specifications for the Operating Controls

Keys: The keys do not have specific functions. The different functions assigned to them can be seen in the display.

Direct Access Control (DAC): A Direct Access Control Knob (DAC) can be found next to each mechanical connection. If you press a DAC the information associated with that mechanical connection is shown on the display, e.g. measured variables, range of values, current reading, etc.
Gas type and gas standard is also shown in the header of the display.
The LED above the DAC indicates which connection is active on the display.

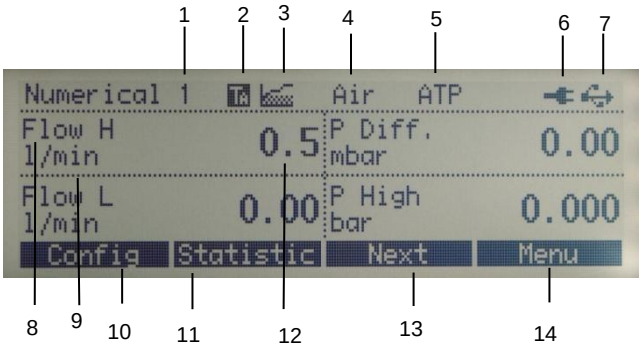


The DAC window of the HighFlow Channel. (***Details*** will show you information about the various other sensors of that channel.)

Power: The LED indicates whether the device is on.

7.6 Numerical Display

When you switch on the device ***Numerical 1*** appears on the display. Four measured values can be displayed on the display at the same time. In the title bar you can see the current settings for the gas type, standard, battery status, mains mode and USB connection.



7.6.1 Specification for the Numerical Display

(1) **Numerical display number**. Altogether there are four different numerical displays, allowing a maximum of 16 values to be displayed.

(2) **Trigger Indication.** This icon indicates the detection of a trigger at the actual ventilation cycle. The icon is displayed for ½ second and indicates the start of a new inspiration. If this icon does not appear the trigger settings need to be adjusted (> 7.14 Setting the Trigger).

As long as there is no trigger event being detected, "**No Trig**" information is shown in the reading field.

(3) **Baseflow.** This symbol appears if the baseflow function has been activated for volume measurement (> 7.14 Setting the Trigger).

(4) **Gas type** currently selected. Depending on what type of gas is being measured, the device must be set accordingly (> 7.13 Gas Type and Standard).

(5) **Standard**. The values displayed will be calculated using the selected standards. Choose from several common gas standards (> 7.13 Gas Type and Standard).

(6) **Power supply**. This symbol appears when the device is connected to the power supply.

The analyzer can also be operated with the built-in battery. A battery symbol appears to indicate battery operation and loading status of battery:

Battery full

Battery empty – Please recharge!
A warning message appears if the battery gets very low (> 5.4 Battery Mode).

(7) **USB**. The analyzer can be connected to a PC via the USB connection. This symbol appears if a connection to the PC has been established.

(8) **Measured variable**. Shows the variable. Variables can be changed in the configuration monitor (> 7.7.1 Specification for the Configuration Display).

(9) **Unit of measurement**. Shows the unit of the variable. Units can be changed in the configuration monitor (> 7.7.1 Specification for the Configuration Display).

(10) **Config.** Press the assigned key to reach the configuration display. Here you can change the variables and unit of measurement (> 7.7 Configuration Display).

(11) **Statistics**. Press the assigned key to reach the statistics display, where you can view the minimum, maximum and average values for the individual variables (> 7.8 Statistics Display).

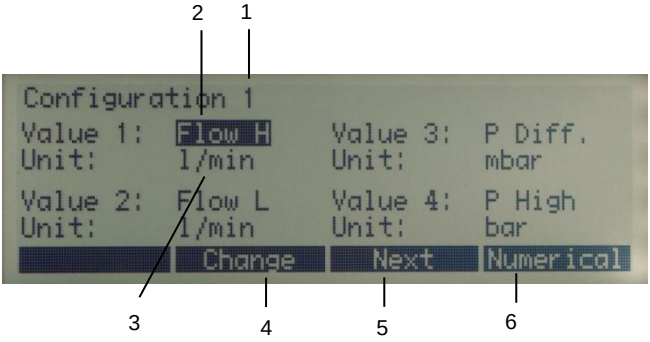
(12) **Reading**. Shows the actual measured value.

(13) **Next**. Use the assigned key to move between the four numerical displays.

(14) **Menu.** Press the assigned key to reach the menu display. You can access the gas type, volume trigger, calibrations, language and system info from the menu.

7.7 Configuration Display

The numerical displays can be configured in the four configuration displays. Here you can change the variables and corresponding units of measurement for all four numerical displays.



7.7.1 Specification for the Configuration Display

(1) **Number** of configuration display. You can switch between four different configuration displays. The number of the configuration display corresponds with the number of the numerical display.

(2) The **measured variable** currently shown on the numerical display (> 15 Appendix B: Values and Units). You can highlight any value in the display by pressing the arrow keys. A red LED alerts you to the corresponding mechanical connection.

(3) The **unit of measurement** used to for the variable in the numerical display (> 15 Appendix B: Values and Units).

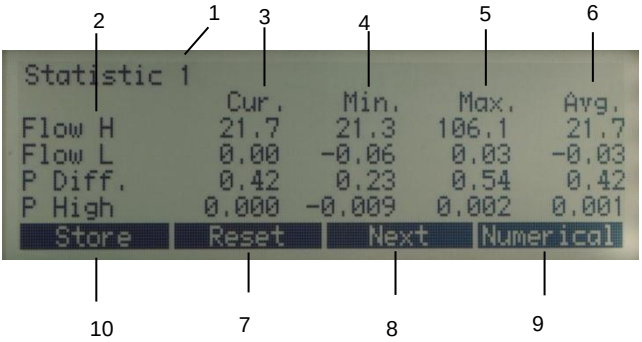
(4) **Change**. This key switches you to edit mode so that you can change the corresponding variable or unit of measurement. Press **Save** to save the new value.

(5) **Next**. Use this key to switch from one of the four configuration displays to the next.

(6) **Numerical**. Press this key to exit the configuration display. The numerical display returns.

7.8 Statistics Display

The four statistics displays show the current readings, minimum, maximum and mean values for the measured variables. The variables in the statistics display correspond with the variables in the numerical display.



7.8.1 Specification of the Statistics Display

(1) **Number** of the statistics display. You can switch between four different statistics displays. The number of the statistics display corresponds with the number of the numerical display.

(2) **Measured variable**. Shows the measured variable. Variables can be changed in the configuration monitor (> 7.7.1 Specification for the Configuration Display).

(3) **Current reading.** Shows the actual measured value using the same units as in the numerical display..

(4) **Min.** This value shows the lowest value measured since the last reset.

(5) **Max**. This value shows the highest value measured since the last reset.

(6) **Mean**. This value shows the arithmetic average of all values measured since the last reset. After one minute a moving average of one minute is displayed.

(7) **Reset**. Press this key to reset the statistical values to zero. Simultaneously, all respiratory parameters will be set to “no Tr”.

(8) **Next**. Use this key to switch from one of the four statistics displays to the next.

(9) **Numerical**. Press this key to exit the statistics display. The numerical display returns.

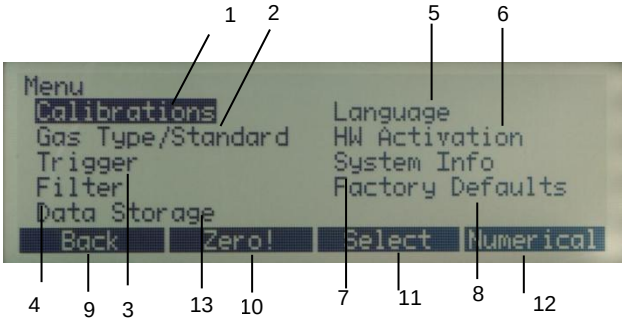
(10) **Store.** Press this key to save measurement parameters.

In the statistic display the same units are being used as defined in the numeric display!

7.9 Menu Display

The following parameters can be viewed and changed in the menu display:

- Calibrations
- Gas type and standard
- Trigger
- Language
- HW Activation
- System information



7.9.1 Specification of the Menu Display

(1) **Calibrations.** The oxygen sensor as well as all pressure and flow sensors and the ***MultiGasAnalyzer™ MGA-3050*** can be calibrated from this submenu. The offset calibration for pressure and flow can also be started by pressing the ***Zero!*** button.

(2) **Gas type/Standard**. The gas type and standard can be specified in this submenu.

(3) The settings in the **Trigger** submenu are used to measure the respiratory values. By choosing different respiration modes standard triggers can be selected.

(4) By selecting a **Filter** the displayed values of the Screen can be averaged over a certain time.

(5) **Language**. Select the desired language here.

(6) In the **HW Activation** submenu you can see if the USB port or the communication to the MGA-3050 multi gas sensor is enabled.
If the ***FlowLab™*** software or the integration of the gas sensor was ordered at a later date, you will need to enter a clearance code before a connection can be made.

(7) **System info** contains information on the software and hardware versions, as well as data of the last factory calibration.

Pressing the keys 2 and 3 simultaneously will hide all menu content that impacts the measurements. This avoids unwanted changes of the settings.

(8) **Factory Default** button gives you the option or resetting your ***FlowAnalyzer™*** to the original delivery settings.

(9) **Back** always brings you one level back. In this screen it will bring you to the numerical values.

(10) **Zero!** Starts an offset calibration for the pressure and flow sensors.

Attention: During this "fast calibration" no warnings are displayed and the screen will change at the end automatically to the numerical values.

(11) **Select**. Press this key to open the selected submenu.

(12) **Numerical**. Press this key to exit the menu display. The numerical display returns.

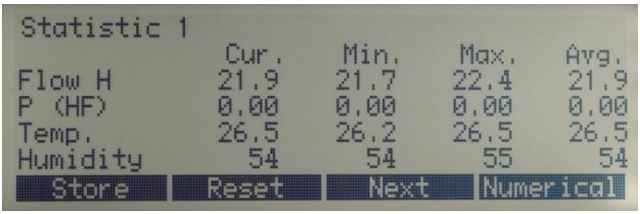
(13) **Data Storage**. Measurement parameters can be saved and viewed.

7.10 Data Storage Capabilities

7.10.1 Storing Data

10 records each containing up to 16 measurement values can be stored directly on the FlowAnalyzer. The selected gas standard and gas type are automatically stored in the data record.

Step 1



1. Enter the **Statistics** display (>7.8 Statistics Display)
2. Press **Store** to save the displayed measurement values

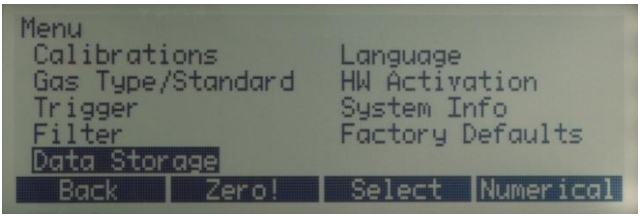
Step 2

1. Select the data no. you would like to store the measurement values under
2. Press **Store**

Warning: If a record is already saved under the number you have selected, the new data will automatically **replace the old data**.

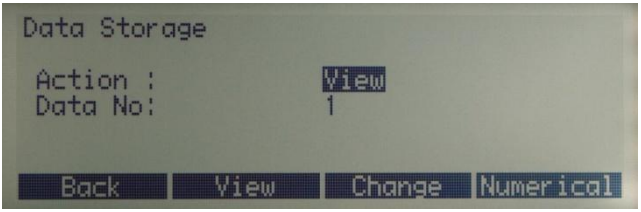
7.10.2 Retrieving Data

Step 1



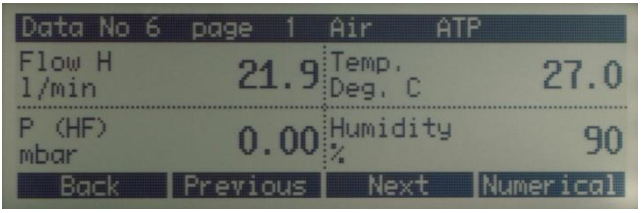
1. Enter the **Menu** display and select **Data Storage** (>7.9 Menu Display)

Step 2



1. Select the **Data No**. you would like to view
2. Press **View**

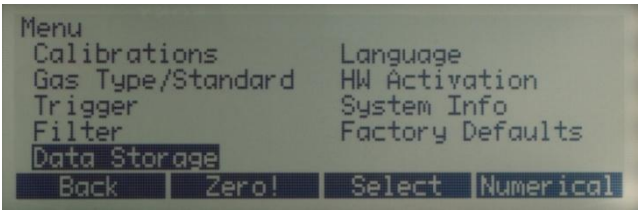
Step 3



1. Scroll through the four pages of your selected data number by pressing **Previous** and **Next**. Once you have viewed all four pages of the selected data number, the first page of the next data number will automatically appear.

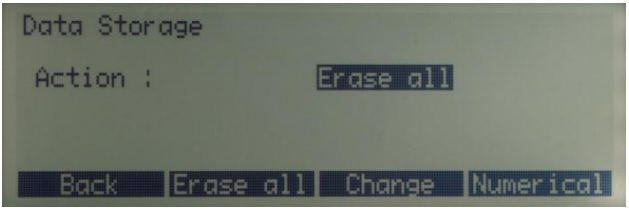
7.10.3 Erasing Data

Step 1



1. Enter the **Menu** display and select **Data Storage** (>7.9 Menu Display)

Step 2



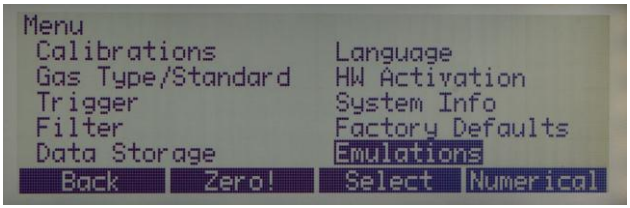
1. Under **Action** select **Erase All**

Warning: If **Erase All** is selected all stored data will be automatically erased.

7.11 RT-200 Emulation Mode

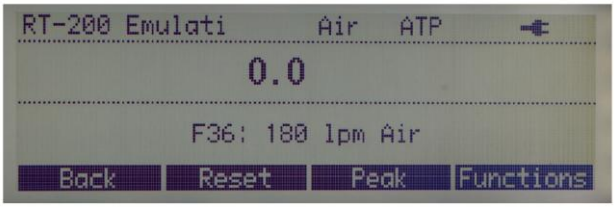
The RT-200 emulation mode simulates RT-200-style commands over the RS-232 interface (6.4.2 RS 232).

Step 1



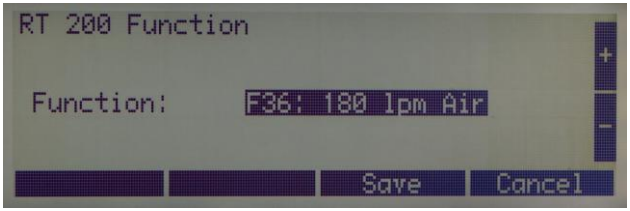
1. Go to **Menu**
2. Select **Emulations**

Step 2



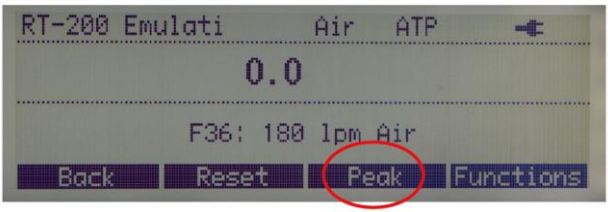
1. **Select** RT-200 Emulation
2. Press **Functions** to change the functions

Step 3



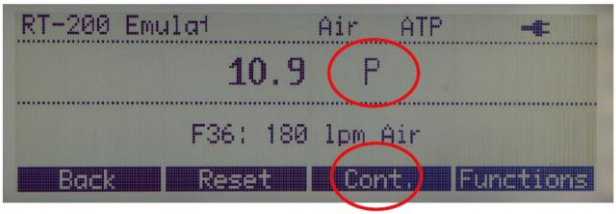
1. Select the function that you would like to measure
2. Press **Save**
3. Press **Back**

Continuous Measuring Mode



This mode allows you to view measurements real-time.
To switch to peak measuring mode, select **Peak.**

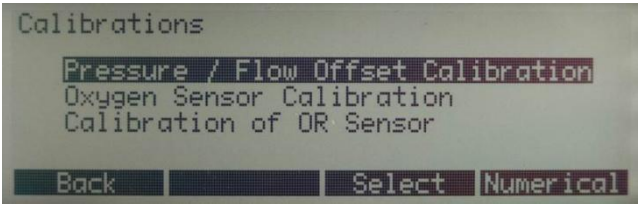
Peak Measuring Mode



This mode allows you to instantly see and evaluate peak measurements.
To switch to continuous measuring mode, select **Cont.**

7.12 Calibrations

All the pressure and flow sensors, the oxygen sensor and the ***MultiGasAnalyzer*™ *MGA-3050*** can be calibrated in this submenu.



7.12.1 Calibrating the Pressure and Flow Sensors

These calibrations are required if a value other than zero is displayed for differential pressure, high pressure or flow, although no connections have been made. This can happen during extreme fluctuations in temperature.

Calibration will reset all values to zero.

For a short time after turning on the instrument some displays may vary slightly from Zero until the optimal operating temperature is reached (10 to 15 Min).

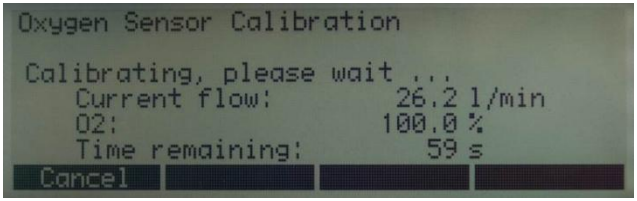
Therefore zero calibrations must not be performed, as long the instrument is cold.

During a zero calibration it is important that no pressure or flow is applied to any connector!

Attention: When performing the offset calibration using ***Zero!*** these warnings are not displayed on the display.

7.12.2 Calibrating the Oxygen Sensor

The oxygen sensor consists of an electrochemical cell and has to be recalibrated from time to time as a result of aging.



When you start the calibration 100% oxygen and then ambient air must be applied, as instructed by the device. During both steps it is essential that enough of each gas flows through the main measuring channel for a sufficient duration.

The calibration takes 75 seconds for each gas. The optimal flow is 20 to 30 l/min and may not be changed during the calibration process.

If you make any changes to the measuring screen of the High flow or Low flow channel, flow measurement will have to be recalibrated. Recalibration can only be carried by the manufacturer or an authorized metrology station.

7.12.3 Calibrating the *MultiGasAnalyzer™ MGA-3050*

Please refer to the special chapter regarding the ***MultiGasAnalyzer™ MGA-3050***.

7.13 Gas Type and Standard

Depending on the gas to be measured, you will first have to set the appropriate gas type on the ***FlowAnalyzer***™ .

Select from the following gas types:

- Air (100%)
- Air/O_2-Man. (Air – O_2 Mixture according to manual input. Standard value is 100% O_2)
- Air/O_2 Auto. (Air – O_2 Mixture according to sensor reading of the internal Mixture cell).
- N_2O/O_2-Man.(Nitrous oxide–O_2 Mixture according to manual input. Standard value is 100% O_2)
- N_2O/O_2-Auto.(Nitrous oxide-O_2 Mixture according to sensor reading of the internal Mixture cell)
- Heliox (21% O_2)
- He/O_2-Man.(Helium-O_2 Mixture according to manual input. Standard value is 100% O_2)
- He/O_2-Auto (Helium-O_2 Mixture according to sensor reading of the internal Mixture cell)
- N_2O (100%)
- CO_2 (100%)

Press ***Change*** to switch between the various options, and select the value with ***Save***. When using ***O_2-Man*** the O_2 Concentration can be changed in the same manner.

Standard conditions are specific conditions for pressure, temperature and sometimes humidity as well, which form the basis for ascertaining the actual measured flow. It is therefore essential that you check precisely which standard condition the displayed value is based on!

The currently selected standard is shown in the numerical display (> 5.2 Standard Conditions for Flow Measurement).

If you press ***Change*** you will see a plus and minus, which you can use to switch between the different options. Select the value with ***Save***.

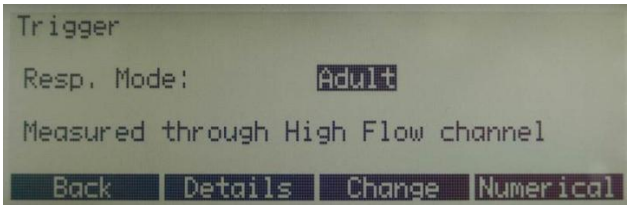
Selecting the wrong gas type or wrong gas standard can lead to measurement inaccuracies of up to 20%.

7.14 Setting the Trigger

The beginning and end of volume calculations and respiratory parameters are determined by means of a trigger. The trigger can be set to start and stop according to flow or pressure in the high flow channel (> 10 Measuring Respiratory Coefficients).

7.14.1 Selection of Ventilation Mode

Over the selection of the ventilation mode you can adjust reasonable standard trigger values for each mode. Using these standard triggers 90% of all measuring tasks can be performed.



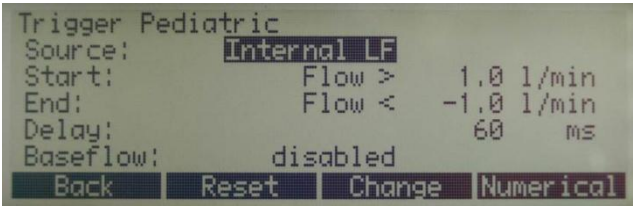
You can choose out of the following Ventilation modes:

- Pediatric Ventilation (The flow measurement will be taken on the Low Flow Channel where as the pressure is measured on the connector for differential pressure Pdiff)
- Adult Ventilation (Measurements in the High Flow Channel.)
- High Frequency Ventilation (Measurements in the High Flow Channel.)

7.14.2 Standard Trigger

Each Ventilation Mode is related to a set of standard triggers. By pressing ***Reset*** you can always come back to these standards.

Standard Trigger for Pediatric Ventilation:



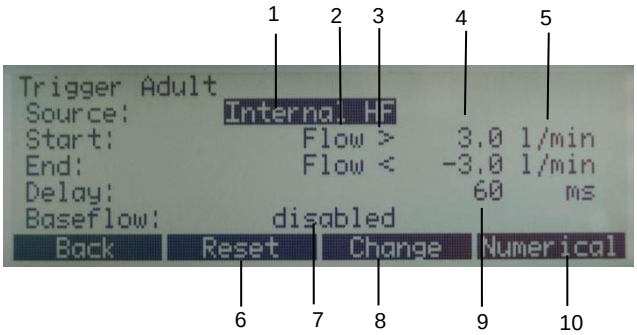
Attention: The measurements in the pediatric mode are taken in the Low Flow Channel. The appropriate pressure values have to be measured on the Pdiff connector. This is why the Pdiff has to be connected to the flow channel using a T-connector.

If the trigger mode is set to pediatric, a pressure compensation for Low Flow Channel is activated automatically.

Standard Trigger for Adult Ventilation:

Standard Trigger for High Frequency Ventilation:

7.14.3 Detailed Trigger Settings



(1) **Flow channel.** Here you can change the measuring channel (HF = High Flow; LF = Low Flow).
Further on you can decide whether the internal values (Flow or Pressure) are used to detect a trigger or whether an external trigger shall be used (> 7.14.4 Usage of an External Trigger).

(2) **Variable** used for the start and stop triggers. You can select either pressure or flow in the High flow channel.

(3) **Trigger edge**
> Positive edge (rising curve)
< Negative edge (falling curve)

(4) **Trigger level.** If this level is passed , volume measurement will start or stop. The level must be in the range of -250...250 lpm (HF channel) or -15...15 lpm (LF channel)

(5) **Unit of measurement** for the selected start and stop trigger variable.

(6) **Reset**. Press the assigned reset key to load the default values for the trigger. Most volumes can be measured with these settings
(> 0).

(7) **Baseflow.** Here you can switch the baseflow on and off. The baseflow is a constant flow which should not be included in the calculation. If this function has been selected, a corresponding symbol appears in the display (> 7.6 Numerical Display).

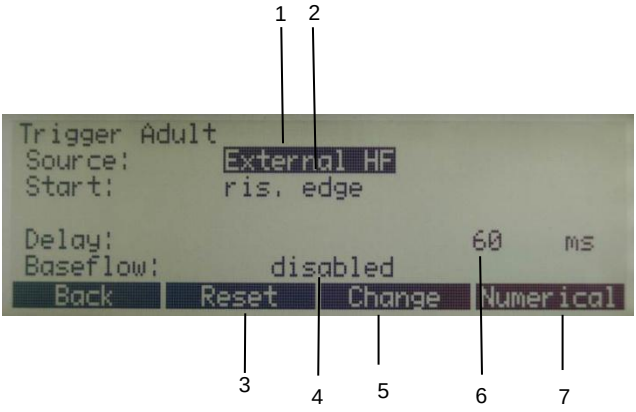
(8) **Change**. This key takes you to edit mode, where you can change the corresponding variable.

(9) The **Delay** prevents that a single spot will release a trigger. If the appropriate trigger level is not maintained for the duration of the selected delay the trigger will not be accepted.

High Frequency mode uses as standard a short delay!

(10) **Numerical**. Press this key to exit the statistics display. The numerical display returns.

7.14.4 Usage of an External Trigger



(1) **External.** An external trigger signal is used to calculate the volume (> 6.4.3 External Trigger).

(2) **Start.** Specify whether volume measurement should take place upon a rising or falling edge in the signal.

(3) **Reset**. Press the assigned reset key to load the default values for the trigger. Most volumes can be measured with these settings.

(4) **Baseflow.** Here you can specify the baseflow. The baseflow is a constant flow which should not be included in the calculation. If this function has been selected, a corresponding symbol appears in the display (> 7.6 Numerical Display).

(5) **Change**. This key takes you to edit mode, where you can change the corresponding variable.

(6) The **Delay** prevents that a single spot will release a trigger.

(7) **Numerical**. Press this key to exit the statistics display. The numerical display returns.

7.15 Filter

The display of the ***FlowAnalyzer™*** is updated every 500ms or in other words twice a second. The acquisition of new measuring values takes place every 5ms. Without using a filter the latest measured value will be displayed when updating the screen.

Since each measurement is showing some noise it makes sense to average the values over a certain period of time. This is the meaning of the filter function.

You can select one of the following filters:

- None (Display of the latest measured value without thresholds)
- Low (Mean value over 240ms)
- Medium (Mean value over 480ms)
- High (Mean value over 960ms)

The standard filter is Medium. Press ***Change*** and scroll through the different filters using the arrow keys. Press ***Save*** to save the selected filter.

The filter function does only impact the values displayed on the screen of the FlowAnalyzer.

The ***FlowLab™*** Software does always show the raw, unfiltered values.

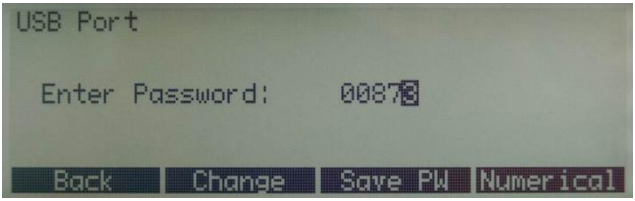
7.16 Setting the Language

The display can be set to a number of languages. The available languages are continuously being revised and updated.

Press ***Change*** and scroll through the different languages using the arrow keys. Press ***Save*** to save the selected value.

7.17 HW Activation

In the submenu **HW Activation** you can see if the USB port or the communication to the ***MultiGasAnalyzer™ MGA-3050*** is enabled.
If the ***FlowLab™*** software or the integration of the gas sensor was added later, you will have to enter a clearance code, before you can use the optional feature.



To enter the code press ***Release***. Various numbers then appear, which can be selected with the arrow keys. Using ***Change*** you can set each individual number to the correct value, and then save it with ***Save***.
Once all digits have been adjusted press ***Set PW*** to save the code. ***Enabled*** will appear on the screen if the code entered was correct. Please enter the code with right justification, and leave the remaining positions as 0.

7.18 Accessing System Info

The following information can be found here:

- Software version
- Hardware version
- Date of last factory calibration
- Serial number of device

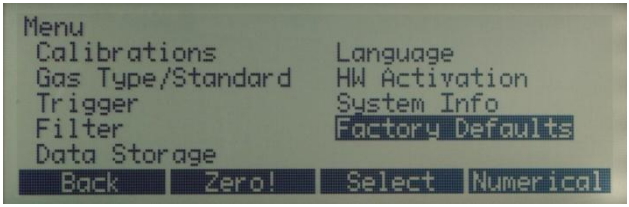
7.19 Invisible Menu Options

In the ***System Info*** Menu it is possible to make invisible all menu options that contain settings which have an impact on the measurements. This avoids unwanted changes, e.g. when used in a production line.

Press the keys 2 and 3 simultaneously while the ***System Info*** menu is active to make the options invisible.

Enter ***System Info*** again and press the keys 2 and 3 simultaneously to get back all menu options visible.

7.20 Factory Defaults



The Factory Defaults setting allows you to re-set your ***FlowAnalyzer™*** settings to the delivered, neutral settings.

Please note: the new settings can only be activated by turning off and re-starting your ***FlowAnalyzer™*** equipment.

8 *FlowLab™* Software

8.1 Installation

Check that your computer meets all minimum requirements before installation (> 5.7 Minimum PC Requirements). Please observe the software instructions during the installation process.

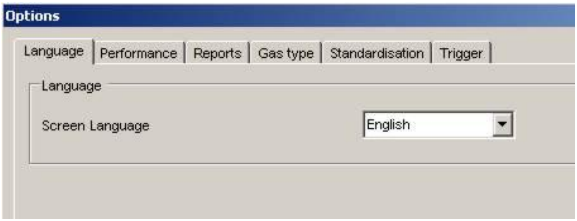
8.2 USB Communication

If your device was not configured to use ***FlowLab™*** software in the factory, you will need to do this afterwards by entering a clearance code for the USB interface. This code can be obtained from your ***FlowAnalyzer™*** dealer (> 7.17 HW Activation).

8.3 Overview

FlowLab™ software is divided into three areas: panels, numerics and trending. Select the required area from the icons on the left-hand side of the ***FlowLab™*** window. The three areas will be described in the following chapters.

8.4 Options

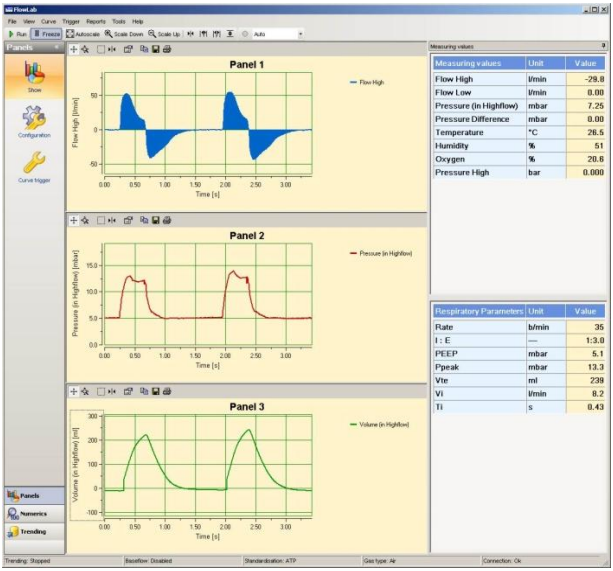


In the **Tools / Options** menu you can set the same settings as in Menu of the ***FlowAnalyzer™***: ***Language,*** gas ***Standardisation, Gas type*** and ***Triggers***. (> 7.9 Menu Display).

Warning: Except of the language the device will adopt any changes that you make here to the FlowAnalyzer!

Additionally you can find the setting ***Performance*** where you can change the update rate for your monitor and the configuration area for ***Reports***. (> 8.8 Reporting).

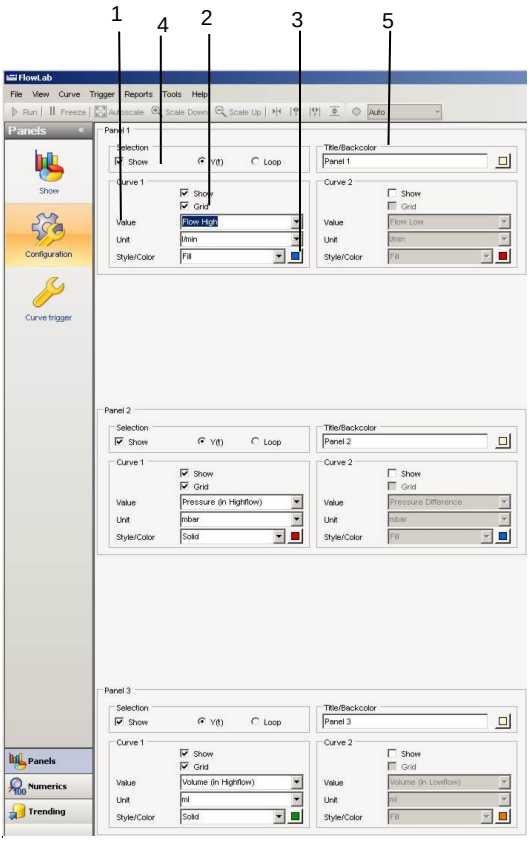
8.5 Panels



A maximum of 6 readings can be graphically displayed here. All related settings can be made in the **Configuration** menu.

8.5.1 Configuration

Whenever you select a variable the corresponding mechanical connection is highlighted in the box on the right-hand side, and the range is shown below.



(1) **Value.** Measured variable and its unit of measurement.

(2) **Grid.** A grid can be displayed.

(3) **Line** color and it's type can be chosen.

(4) **Curve type**. The curve can be chosen in function of the time or as loop. For the display of a loop two values have to be selected, one for the x-axis and one for the y-axis.

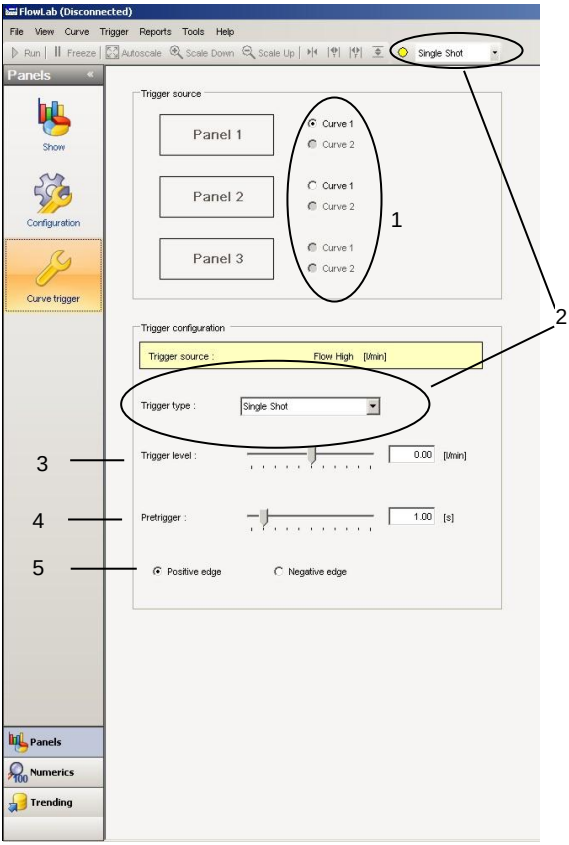
(5) **Title/Background color**. Each chart can here be identified by title. The back color of the chart can be changed.

8.5.2 Curve Trigger

The menu ***curve trigger*** is relates to the graphical display of the curves.

If the curve shall be displayed as Norm- or Single Shot Curve, curve triggers are needed to start the display.

Do not confuse this trigger with the volume trigger, which calculates volumes and respiratory coefficients (> 7.14 Setting the Trigger).



(1) **Trigger source.** Here you can choose the curve which shall be adjusted below.

(2) **Trigger type.** Here you can choose the type of the trigger. This setting stays the same for all curves. There are three different types:

- ***Auto***: This always displays the updated curve. No curve triggers are needed!
- ***Norm***: This displays a static curve, which is updated with each new trigger.
- ***Single Shot***: Use this function to capture a single curve. The trigger has to be activated manually.

(3) **Trigger level.** The curve starts to be displayed when the measured value passes this level.

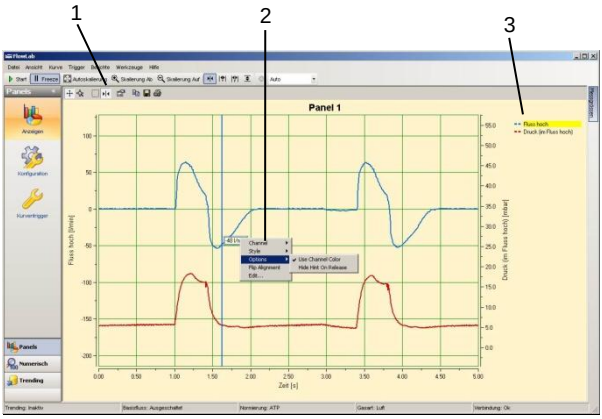
(4) **Pretrigger.** If a certain period of the curve has to be displayed prior the effective trigger point this can be adjusted here.

(5) **Edge** for the trigger.

8.5.3 Cursors

If you wish to look at a curve in more detail, this can easily be done with the cursors provided. Altogether there are 4 different styles of cursor:

Value Y	Displays the Y value at the point where the cursor is intersected.
Period	Displays the time period between two cursors.
Frequency	Displays the frequency between two cursors.
Peak - Peak	Displays the Y value between two cursors.



(1) **Global Cursor**. By choosing one of the 4 corresponding icons you can select a cursor to apply to all displayed curves in the corresponding style.

(2) **Individual Curser**. It is also possible to apply a cursor only for one curve. If you right-click the cursor, a menu pops up where you can change the style of the cursor.

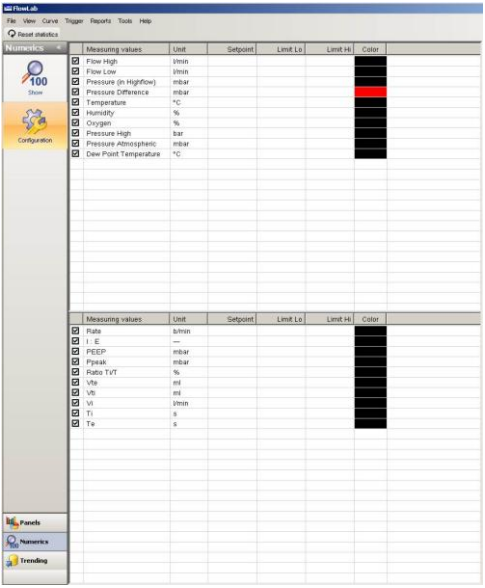
(3) **Curve.** If two curves are displayed simultaneously in one panel, you can click the corresponding curve title to select the curve relating to the cursor.

8.6 Numerics

In this area the data are numerically displayed. The statistical values for each variable can also be seen here, i.e. the mean value, and the smallest and largest value since the last reset. Further it's possible to check the tolerance of each measurement. If the measured value is fitting to the predefined accepted measurement range, the software will mark the value with: ✓

The general sensor variables are in the top section and the respiratory parameters in the bottom section.

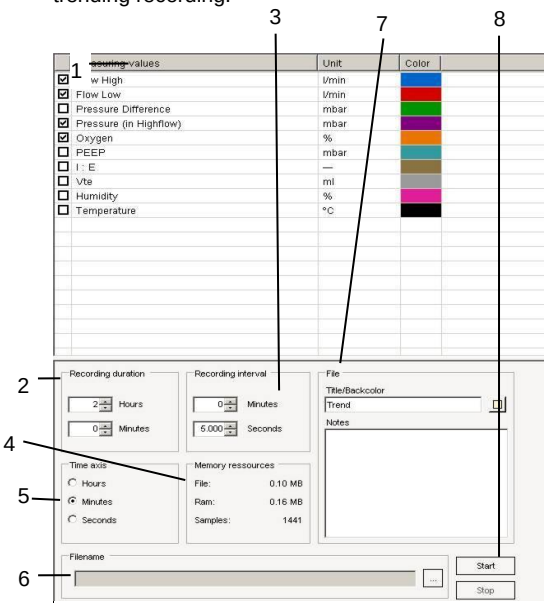
The overall appearance of the Numerics display can also be adjusted to individual requirements in the **Configuration** menu.
In the columns ***Setpoint, Limit Lo*** and ***Limit Hi*** you can set the conditions for the automatic check of the measurements.



8.7 Trending

In this area measurements can be recorded within a specific time range. Select the **Configuration** menu to start a specific trending recording.

8.7.1 Configuration



(1) In the field **Measured Variables** you can define the variables and units of measurement to be recorded. You can also select the color of the graphical display. The corresponding mechanical connection and possible measurement range can be found in the box at the top right-hand section of the display.

(2) In the field **Recording duration** you can specify the length of the data recording. The range goes from 1 minute to 100 hours.

(3) The field **Recording interval** defines how often data should be recorded. Select from a range of 0.1 seconds to 60 minutes.

(4) In the field **Memory resources** you can check the expected file size and required working memory.

(5) In the **Time axis** field you can select the unit of measurement which applies to the x-axis.

(6) In the **File name** field you can specify the file name and storage location.

Depending on the recording time and interval very large files can be produced which can cause problems with the computer.
Under normal circumstances we recommend a maximum file size of 1 MB.

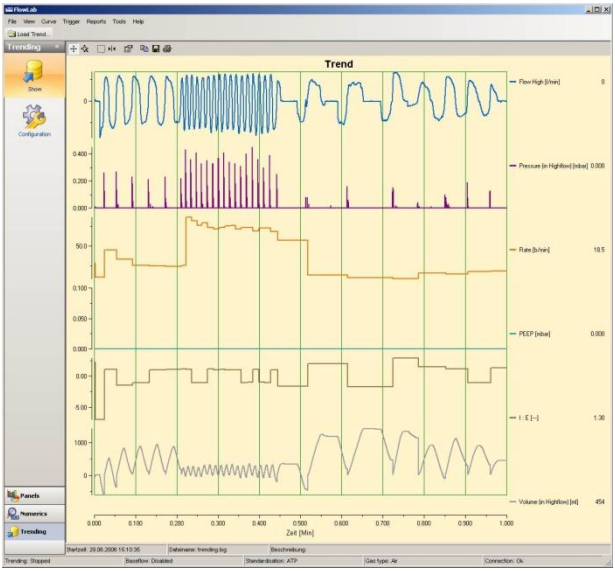
(7) The section **File** enables you can to enter a title, which will be displayed above the trending curves. Descriptive notes will be copied to the trending file but are not shown in the ***Display*** section.

(8) Once the ***Start*** button is pressed, the data are captured as defined and displayed online.

Two files will be generated: The *.log file is containing all measurements and can be used by Excel or other data base systems. The *.cfg file contains the information for ***FlowLab™*** to be able to reopen the trending files.

You can follow the data acquisition in the ***Display*** menu.

8.7.2 Display



In the ***Display*** view the curves can be visualized and analyzed. You can use the same zooming functions and cursors as with the ***Panels***.

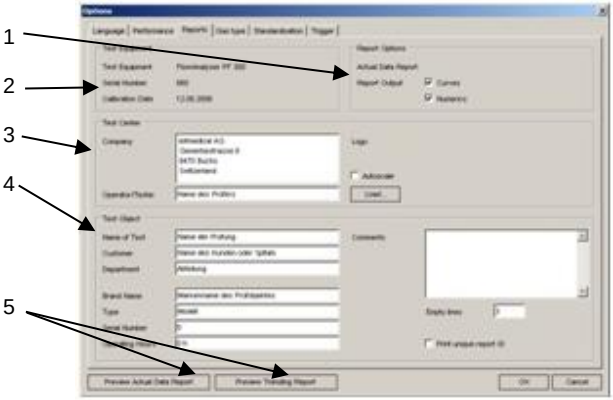
By pressing ***load trend*** you can load another trending file which has been produced earlier.

8.8 Reporting

The reporting function is to print out your measurements in a sheet which includes the measured numerical data, the curves, the company's data and descriptions.

8.8.1 Configuration

In the Configuration menu you can configure all heather information of the reports as well as what shall be printed on the report.



(1) In the ***Reporting Options*** area you can select whether numerical data and/or curves shall be printed in the report.

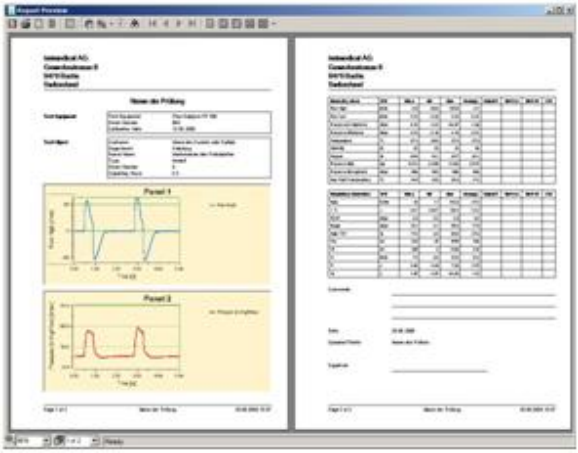
(2) In the ***Test Equipment*** area you see all information regarding the connected ***FlowAnalyzer***™ . The data is automatically loaded from the device.

(3) In the ***Test Center*** field you can edit the company's data and there is also the possibility to load your company's logo to be shown in the report.

(4) Use the ***Test Object*** area to edit the information about the test object, such as place of test, tested instrument or serial number of the instrument under test.
Further you can define to print a unique ID number in the footer of the report.

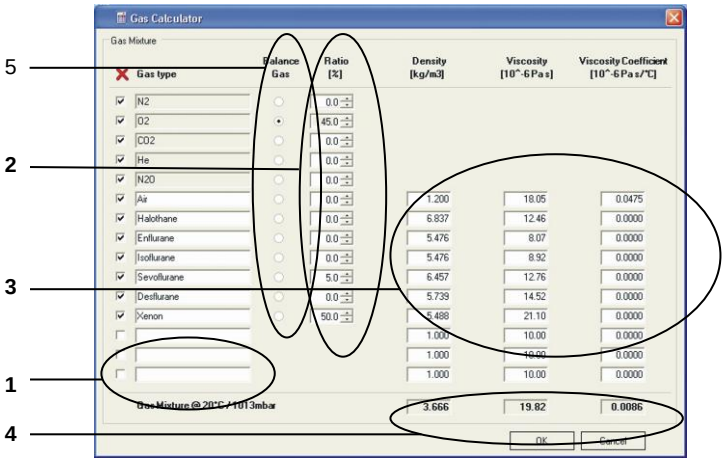
(5) With the ***Preview Actual Data Report*** button an actual data report can be produced, which displays the actual numerical data and curves.

On the preview screen you have access to the printing options as well as to page layout and save settings options.



8.9 Gas Calculator

The gas calculator enables users to configure a mixture of varying gas fractions for flow and volume measurements. Users can select the ratio of standard gases as well as the ratio and physical characteristics of customized gases.



(1) Customized gases (user-defined)

(2) Ratio of the total gas volume

(3) Physical characteristics (entered by the user)

(4) Total gas mixture

(5) Balance Gas (The ratio of the balance gas is automatically calculated. The sum of the ratios must be 100%.)

8.10 *FlowLab™* Settings

In the header toolbar menu listing under **File** the **Load FlowLab Settings…** and **Save FlowLab Settings** options allows users to save and load user-defined settings.

The following settings can be saved using this important menu function:

- Panels
- Numerics
- Trending
- Reports

The settings are then saved as an ***.ini*** File.

9 *MultiGasAnalyzer™ MGA-3050*

9.1 Description

The ***MultiGasAnalyzer™ MGA-3050*** head comprises a state-of-the-art ten-channel non-dispersive infrared (NDIR) gas bench, a barometric pressure sensor, a power regulator, a CPU and an RS-232 digital interface.
The sensor measures concentrations of

- Carbon dioxide Dioxide (CO_2),
- Nitrous oxide Oxide (N_2O),
- Halothane (HAL),
- Enflurane (ENF),
- Isoflurane (ISO),
- Sevoflurane (SEV),
- Desflurane (DES)

At the same time you can measure CO_2, N_2O and one of the five narcotic agents.

9.2 Intended use

The ***MultiGasAnalyzer™ MGA-3050*** is intended to be connected to the ***FlowAnalyzer™*** for gas measurements in order to calibrate or test anaesthetic systems.

It is **not** intended to be used in means of monitoring a patient.

It is **not** intended to be used in outdoor transport applications, such as in cars or in aircrafts.

9.3 Warnings

The ***MultiGasAnalyzer™ MGA-3050*** is intended for use by professionally trained personnel only.

The ***MultiGasAnalyzer™ MGA-3050*** must not be used with flammable anaesthetic agents.

Used disposable airway adapters shall be disposed of in accordance with local regulations for contaminated and biologically fluids.

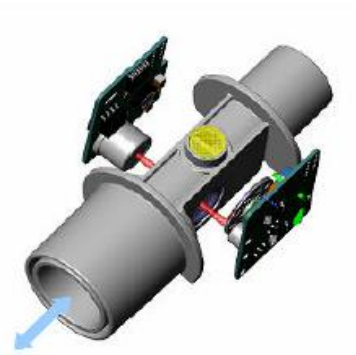
Measurements can be affected by mobile and RF communications equipment.

It should be assured that the ***MultiGasAnalyzer*** is used in the electromagnetic environment specified.

9.4 Design and theory

The ***MultiGasAnalyzer*™ *MGA-3050*** consists of an OR-sensor head (1), an oxygen sensor cell (optional) (2) an airway adapter (3) and an adapting cable (4).
The OR sensor head snaps in place on the top of the airway adapter that includes the optical components for measuring all gases.
As all necessary calibration constants are stored within each sensor head, the probes can be replaced without the need for recalibration.

The measurement of CO_2, N_2O and anaesthetic agents in the gas mixture is based on the fact that the different gas components absorb infrared light at specific wavelengths. The gas measurements are obtained by continuously measuring the infrared gas absorption in the gas flow through the adapter.



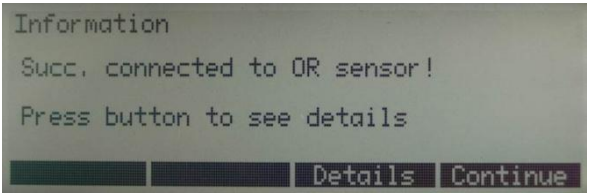
To measure the concentrations and identify the gases, absorption of up to ten different wavelengths of infrared light is measured.

9.5 How to connect

Plug the OR sensor via adapter cable into the RS-232 input of the ***FlowAnalyzer***™ and switch the power on. Only use the adapter cable provided by ***BC Group International, Inc.***.

Snap the OR sensor head on top of the OR airway adapter. It will click into place when properly seated. Wait for 15 Minutes until measurements are taken, the sensor needs to warm up.

A green LED indicates that the OR sensor is ready for use.



The above message will appear to show that connection has been established successfully. By selecting ***Details*** all technical information regarding the sensor will be displayed.

Always position the OR-sensor with the LED pointing upwards.

Place the ***MultiGasAnalyzer™*** between gas source and ***FlowAnalyzer™***.

According to flow direction through ***FlowAnalyzer™*** the ***MultiGasAnalyzer™*** can be connected on front or back airway connector of ***FlowAnalyzer™***.

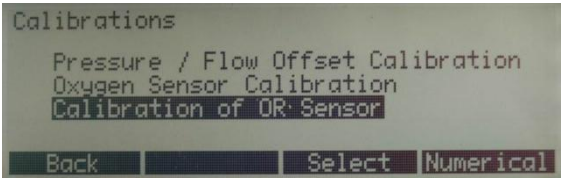
9.6 LED Signal

The LED situated on the ***MultiGasAnalyzer™ MGA-3050*** sensor head is used to signal the following conditions:

Steady green light	System OK
Steady blue light	Anaesthetic agent present
Steady red light	Sensor error
Blinking red light	Check adapter

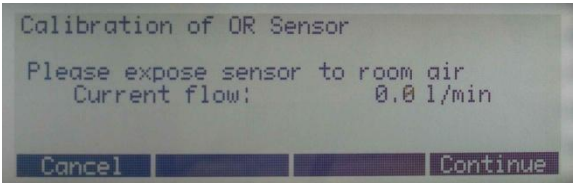
9.7 Calibration of Sensor head

A room air calibration of the IR measurement should be performed at regular intervals as well as after replacing the airway adapter.
The need for a room air calibration is indicated by the 'permanent' alarm message ***Room air calibration of OR required!*** being displayed on the monitor (message disappears after calibration).
Room air calibration may also be performed if an offset in gas readings should be discovered when verifying gas readings with a reference instrument. The calibration is performed by snapping a new OR airway adapter onto the OR sensor, without connecting the airway adapter to the airway circuit, and then start the calibration procedure in the menu options of the ***FlowAnalyzer™*** (>7.12.3 Calibrating the *MultiGasAnalyzer™ MGA-3050*). It will click into place when properly seated. Wait for 15 Minutes before continuing, the sensor needs to warm up.



When replacing the airway adapter, a zero calibration must be performed.

Special care should be taken to avoid breathing into the adapter during the calibration procedure. The presence of ambient air (21% O_2 and 0% CO_2) in the OR airway adapter is of crucial importance for a successful room air calibration.



Always perform a pre-use check after performing a calibration.

9.8 Preventive maintenance

The sensor can be cleaned using a cloth moistened with ethanol or isopropyl alcohol.

Gas readings should be verified at regular intervals with a reference instrument. ***BC Group International, Inc.*** is offering a service for recertification the measurements of the sensor.

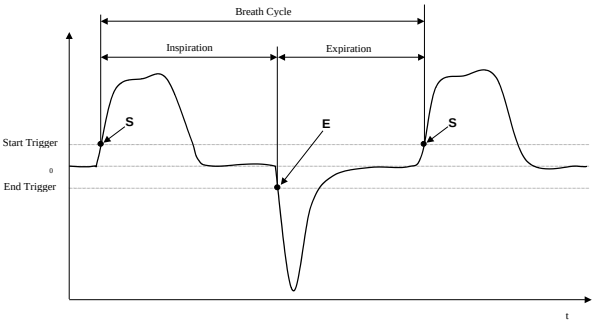
9.9 Specifications *MultiGasAnalyzer™ MGA-3050*			
Physical Data	Dimensions (W x D x H)	1.49 x 1.14 x 1.22 inches (38 x 29 x 31 mm)	
	Weight	< 25 g (cable excluded)	
	Cable length	8.2 feet ± 1 inch (2.50 m ±0.02)	
Environmental Data	Operating temperature	10...40 °C (50...104 °F)	
	Storage temperature	–20...50 °C (-4...122 °F)	
	Operating humidity	10–95% RH, non-condensing	
	Storage humidity	5–100% RH, condensing	
	Operating atmospheric pressure	700-1200 hPa (700 hPa corresponding to an altitude of 3048 m)	
Accuracy specifications	Gas	Range	Accuracy
	CO_2	0-10%	±(0.2% ABS + 2% REL)
		10-20%	±(0.3% ABS + 4% REL)
	N_2O	0-100%	±(2% ABS + 2% REL)
	HAL, ISO, ENF	0-8%	±(0.15% ABS + 5% REL)
		8-12%	±(0.2% ABS + 10% REL)
	SEV	0-10%	±(0.15% ABS + 5% REL)
		10-15%	±(0.2% ABS + 10% REL)
	DES	0-22%	±(0.15% ABS + 5% REL)
		22-25%	±(0.2% ABS + 10% REL)
Rise time (@ 10 l/min)	CO_2 < 90 ms O_2, N_2O, HAL, ISO, ENF, SEV, DES < 300 ms		
Monitoring	Numerical Data and Real-time Waveform with ***FlowLab™*** Software		

Interference at indicated gas level. For example, 50 vol% Helium typically decreases the CO2 readings by 6%. This means that if measuring on a mixture containing 5.0 vol% CO2 and 50 vol% Helium, the measured CO2 concentration will typically be (1-0.06) * 5.0 vol% = 4.7 vol% CO2.

10 Measuring Respiratory Coefficients

10.1 General

To be able to measure respiratory coefficients the ***FlowAnalyzer***™ has to be able to pick out a respiratory cycle from the pressure and/or flow curves. The triggers are controlling this.



It is therefore essential that the start and stop triggers are correctly defined, as they have a significant effect on the resulting measurements.

The set triggers are used to trigger a respiratory cycle (> 7.14 Setting the Trigger).

It is therefore very important that the triggers are set correctly before starting to measure the respiratory coefficients.

The start trigger is defined as the start of the inspiration phase.

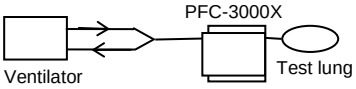
The stop trigger is defined as the end of the inspiration phase and start of the expiration phase.

Expiration continues until the next start trigger appears.

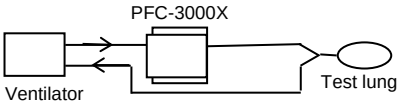
10.2 Connection to the Ventilator

There are three different ways to connect the ***FlowAnalyzer™*** to the ventilator:

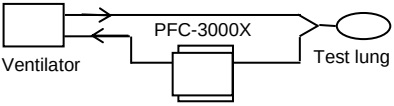
A. After the Y-piece



B. In the inspiration channel before the Y-piece



C. In the expiration channel before the Y-piece



10.3 Standard Trigger Values

As the ***FlowAnalyzer™*** can measure flows in both directions, connection A would seem to be the best option. With this configuration the flow is usually selected as trigger variable. The standard trigger values for the flow trigger are:

- Start trigger: Flow > 3 l/min
- End trigger: Flow < -3 l/min

Further standard triggers you will find in the chapter Operation: (> 7.14.2 Standard Trigger)

Pressure is usually used as the trigger signal for connections B and C. In this case the standard values are as follows:

- Start trigger: Pressure > 1 mbar
- End trigger: Pressure < 1 mbar

10.4 Baseflow

Baseflow refers to a constant base flow that is not included in the volume calculation.

For example, if there is a definite leak in the system, which constantly loses 3 l/min air, these 3 l/min are not part of the inspiration volume. By entering

- Baseflow: On 3.0 l/min

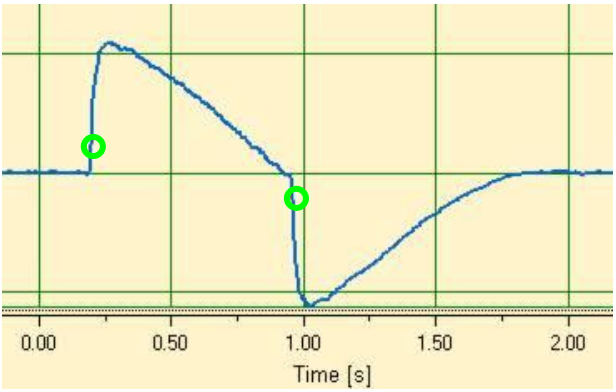
The volume calculation can be corrected for this example.

10.5 Finding the Correct Trigger Values

The first time you have to set a trigger you need to know the curve pattern of the signal used for the trigger (flow or pressure). We therefore advise that you observe this curve first with the ***FlowLab***™ software. On the graph it is then very easy to see where the triggers should be set.

Below are a few examples to illustrate possible problems.

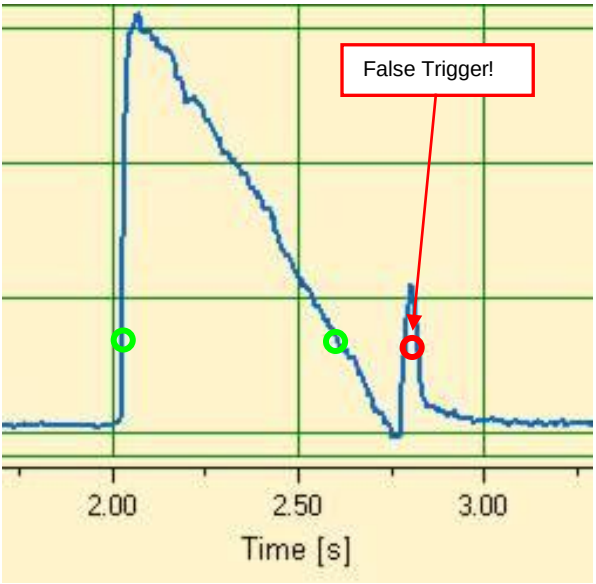
10.5.1 Flow curve after Y-Piece



This example shows a normal flow curve. Standard triggers (> 3 l/min / < -3 l/min) can be used here without any difficulty.

In this situation you must ensure that the trigger is set well above the noise in the base line, as this may trigger false readings.

10.5.2 Flow curve before Y-Piece

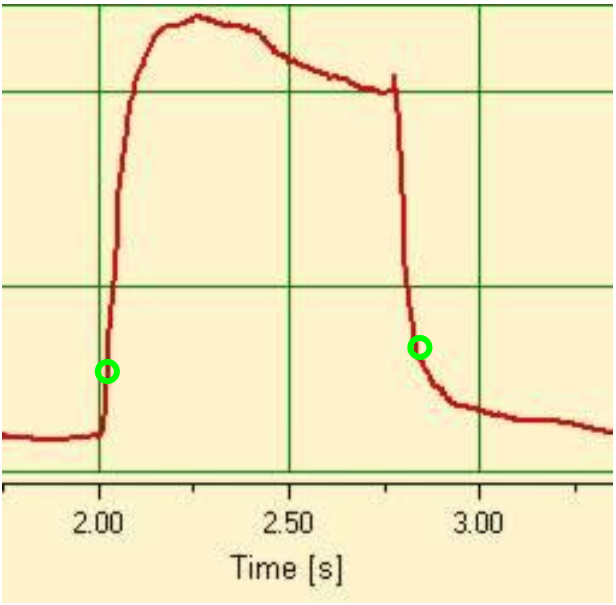


This curve shows the flow curve in the inspiration channel before the Y-piece. The first two circles mark the triggers that should be used here.

The figure above shows another little false signal at this measuring point after inspiration. This was due to the valves switching over and caused a false trigger!

Warning: Flow may not be used as the trigger in this instance – the pressure curve should be used.

10.5.3 Pressure curve before Y-Piece



The standard triggers can again be used for the pressure curve: (> 1 mbar / < 1 mbar).

However, please ensure here as well that the trigger is set well above the noise of the base line. If not the value must be raised.

Please note that it is very easy to work out where the trigger should be set by using the cursor in the ***FlowLab***™ software (>8.5.3 Cursors).

10.6 Special situations

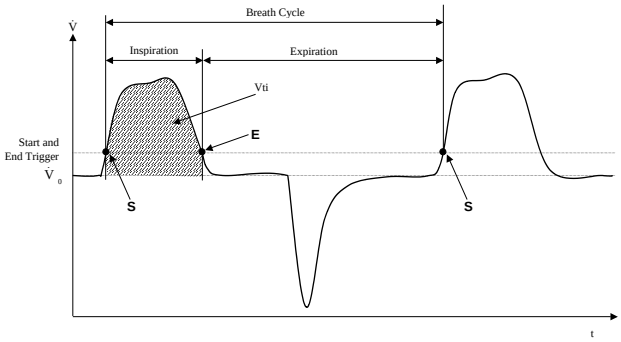
The use of a standard trigger threshold enables the acquisition of very good calculated data, usually of higher accuracy than the ones calculated by today's ventilators. More accurate calculated data may indeed be obtained by setting different trigger thresholds.

If the values of the ***FlowAnalyzer***™ have to be compared to the values of a ventilator it is important to know exactly how the requested value is measured or calculated in the ventilator.

10.6.1 Inspiration Volume Vti

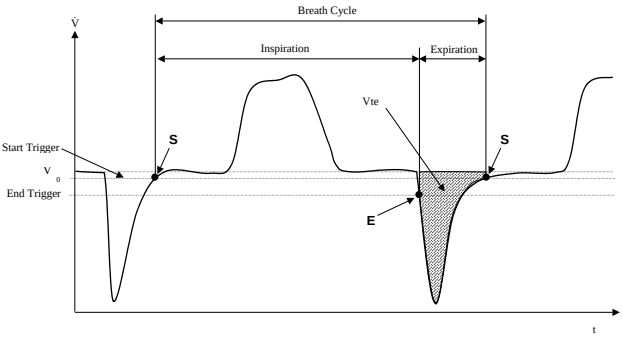
When the ventilation cycle reaches a plateau or a pause, the inspiration flow is technically zero, however, a very small flow could remain and be measured and integrated. Most current ventilators do not count this flow into the volume calculation.

By adapting the trigger settings as described below, one can set the ***FlowAnalyzer™*** to disregard these measurements:



10.6.2 Expiration Volume Vte

A similar situation could arise while measuring Vte:



11 Care and Maintenance

11.1 Guidelines for Care and Maintenance

Maintenance work must be carried out with care and according to regulations to ensure that the ***FlowAnalyzer™*** functions safely and effectively. Only use manufacturer's recommended parts (>**Error! Reference source not found. Error! Reference source not found.**).

Guidelines and maintenance tips provided by the individual manufacturers must be explicitly followed.

11.2 Notes on Replacing Components

The maintenance work listed below should only be carried out by experienced personnel who are familiar with the ***FlowAnalyzer™*** . All other repairs and service should only be carried out by trained personnel. Always refer to the individual manufacturer's instructions.

11.3 Preventative Cleaning and Maintenance Routines

To guarantee the maximum long-term precision and reliability of your device, the following maintenance routines must be carried out at regular intervals:

During operation:

- Always use the protection filter on both channels.

Every four weeks

- Check the protection filter for permeability. This has to be measured as a pressure drop across the filter. Install a T-connector on each input and output of the filter and connect each to the differential pressure port while applying a flow of 60 l/min. The filter must be changed if the pressure drop is greater than 2 mbar.

Every 12 months:

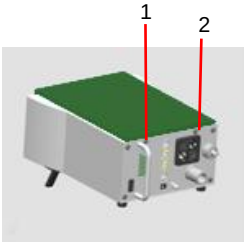
- Factory calibration to ensure accurate and reliable measuring.

11.3.1 Replacing the Measuring Screen

When the measuring screens are replaced flow measurement will require subsequent recalibration. This can only be carried out by the manufacturer or authorized metrology laboratories.

11.3.2 Replacing the Oxygen Sensor

To replace the oxygen sensor the lid must be removed:



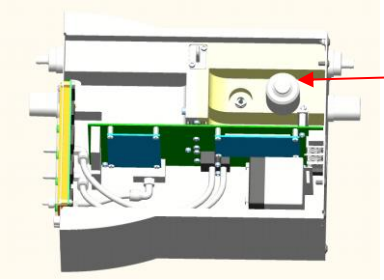
Using an appropriate tool release screws 1 and 2 which hold the lid on.

Push the lid carefully forward.

Lift the cover up.

The oxygen sensor is located inside the analyzer.

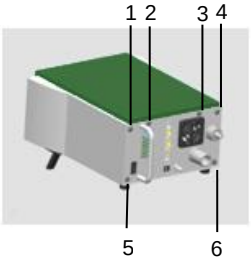
1. Remove the plug from the oxygen sensor.
2. Take out the oxygen sensor by turning counter clockwise.
3. Turn the new oxygen sensor clockwise to insert it into the block and reconnect the plug.



4. Replace the lid.
5. Calibrate O_2 Sensor (> 7.12.2 Calibrating the Oxygen Sensor)

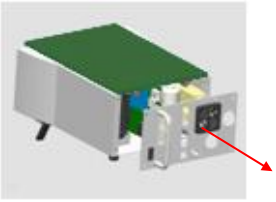
11.3.3 Replacing the Fuses

To replace the fuses you need to remove the back plate:



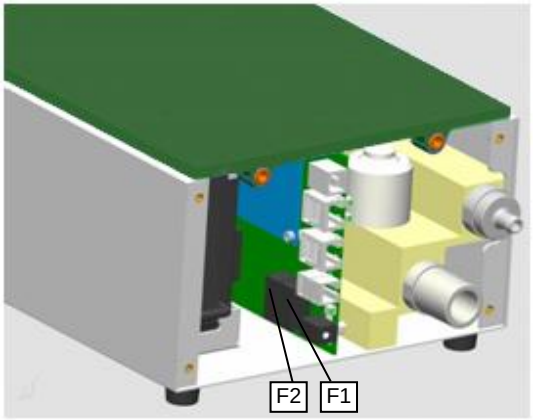
Using an appropriate tool release screws 1 - 6 which hold the back plate on.

Pull the back plate off.



Both fuses are located on the printed circuit board inside the ***FlowAnalyzer***™ .

1. Unplug the battery.
2. Remove the faulty fuse.
3. Insert the new fuse.



(F1) 1.25 A F (external feed 18V)

(F2) 1.25 A F (internal feed 12V)

Only use manufacturer's recommended parts (>12 Accessories and Spare Parts).

4. Replace the back plate.

11.4 Contacts

Please direct any queries or problems to one of the addresses below.

11.4.1 Manufacturer's Address

BC Group International, Inc.
3081 Elm Point Industrial Dr.
St. Charles, MO 63301
USA

Tel: 1-314-638-3800
1-800-242-8428 (toll-free)
Fax: 1-314-638-3200

E-Mail: sales@bcgroupintl.com

11.4.2 Technical Support

Tel: 1-314-638-3800

1-800-242-8428 (toll-free)

E-Mail: service@bcgroupintl.com

12 Accessories and Spare Parts

12.1 Ordering Address

BC Group International, Inc.
3081 Elm Point Industrial Dr.
St. Charles, MO 63301
USA

Tel: 1-314-638-3800
1-800-242-8428 (toll-free)

Fax: 1-314-638-3200

E-Mail: sales@bcgroupintl.com

12.2 Available Models

Item	Order number
FlowAnalyzer™ PFC-3000A	PFC-3000A
FlowAnalyzer™ PFC-3000V Extra Vacuum Sensor	PFC-3000V
FlowAnalyzer™ PFC-3000L Extra Low Pressure Sensor	PFC-3000L

12.3 Options

Item	Order number
FlowLab™ Software	*Please Call*
MultiGasAnalyzer™ MGA-3050	MGA-3050
SmartLung™ Adult	LS-2000A
SmartLung™ Infant	LS-2000I
EasyLung™	LS-1000E

Please visit www.bcgroupintl.com for more information.

13 Disposal

The operator is responsible for the disposal of the device. The operator must either

- Deliver the device, free of charge and duty paid, to the manufacturer for disposal or
- Surrender the device to a licensed private or public collection company or
- Professionally dismantle the component parts and recycle them/dispose of them properly.

Where an operator chooses to dispose of the device himself, the disposal regulations are specified for each country and laid down in the appropriate laws and regulations. Please consult the responsible authorities for instructions on what is required.

With this in mind, all waste is to be recycled or disposed of…

- Without any risk to human health
- Without employing procedures or methods which cause damage to the environment - in particular water, air, earth, flora and fauna
- Without causing any noise or odor nuisance
- Without detriment to the surroundings or landscape.

14 Appendix A: Abbreviations and Glossary

A	
A	Ampere
AC	Alternating current
ASB	Ampere slow blow
B	
bar	1 bar = 14.50 psi
Baseflow	The baseflow is a constant flow which should not be included in the volume calculation.
C	
°C	Degrees Celsius Conversion to Celsius (C) from Fahrenheit (F): F = 9*C/5 + 32
Cstat	Statistical compliance
D	
dBA	Decibels measured with A filter
DC	Direct current
DIN	Deutsche Industrienorm (German Industrial Standards)
DAC	Direct Access Control
Delta P	Amplitude Pressure (Ppeak – PEEP)
E	
EMC	Electromagnetic compliance
F	
°F	Degrees Fahrenheit Conversion to Fahrenheit (F) from Celsius (C): C = (F-32)*5/9
FCC RJ-10	Connection Jack for external Trigger (RJ ... 'Registered Jack', telephone connection interfaces, registered with the FCC, the U.S. Federal Communications Commission)
G	
GND	Ground
H	
Hz	Hertz (1 Hz = 1 s^{-1})
H	Hour
HF	High Frequency
I	
IP	Protection class according to standard
I:E	Breath time ratio, inspiration to expiration
L	
l	Liter
Lbs	Pound
LED	Light Emitting Diode
l/s	Liter per second

M	
Max, max	Maximum
mbar	Millibar (1 mbar = 10^{-3} bar)
Min	Minute
Min, min	Minimum
mm	Millimeter (1 mm = 10^{-3} m)
ml	Milliliter (1 ml = 10^{-3} l)
P	
ppm	Parts per million (1*10^{-6})
prox.	Proximal
psi	Pounds per square inch (1 bar = 14.50 psi)
Ppeak	Peak pressure
Pmean	Mean pressure
PEEP	Positive End Expiratory Pressure
PF Insp.	Peak flow inspiration
PF Exp.	Peak flow expiration
Pplateau	Plateau pressure at the end of inspiration
R	
RH	Relative humidity
RS-232	Serial interface
RJ-10 FCC	Connection Jack for external Trigger (RJ ... 'Registered Jack', telephone connection interfaces, registered with the FCC, the U.S. Federal Communications Commission)
S	
sl/min	Standard liter per minute (calculated using ambient conditions of 0°C and 1013 mbar)
T	
Ti/Ttotal Ti/TCycle	Ratio Inspiration time : Breath cycle time
V	
V	Volt
VA	Apparent power consumption of device
VAC	Volt Alternating Current
VDC	Volt Direct Current
µm	Micrometer (1 µm = 10^{-6} m)

15 Appendix B: Values and Units

15.1 Pressure	Value	Description	Units
	Atmospheric pressure	P Atmo.	mbar, bar, inH_2O, cmH_2O, psi, Torr, inHg, mmHg, hPa, kPa
	Pressure high	P High	
	Pressure in High Flow	P (HF)	
	Differential pressure	P Diff.	

15.2 Flow	Value	Description	Units
	High flow	Flow H	l/min, ml/min, cfm, l/s, ml/s
	Low flow	Flow L	l/min, ml/min, cfm, l/s, ml/s

15.3 Metrology Values	Value	Description	Units
	Temperature	Temp.	°C, K, °F
	Humidity	Humidity	% RH
	Oxygen	O_2	%
	Dew point	Dew Pt	°C, K, °F
	Volume	Vol. (HF)	ml, l, cf

15.4 Gas Concentrations	Value	Description	Units
	Gas concentration	Gas concentration	%
	Partial pressure	Partial pressure	mbar, bar, inH_20, cmH_2O, psi, Torr, inHg, mmHg, hPa, kPa

15.5 Respiratory Parameters	Value	Description	Units
	Endexpiratoric Pressure	PEEP	mbar, bar, inH_2O, cmH_2O, psi, Torr, inHg, mmHg, hPa, kPa
	Mean pressure	Pmean	
	Peak pressure	Ppeak	
	Plateau pressure	Pplateau	
	Amplitude pressure	Delta P	
	Minute volume Expiration	Ve	l/min, ml/min, cfm, l/s, ml/s
	Minute volume Inspiration	Vi	
	Peak Flow Inspiration	PF Insp.	
	Peak Flow Expiration	PF Exp.	
	Expirations Volume	Vte	ml, l, cf
	Inspiration Volume	Vti	ml, l, cf

Rate	Rate	b/min
Ratio	I:E	
Expiration time	Te	s
Inspiration time	Ti	s
Compliance	Cstat	ml/mbar, l/mbar, ml/cm$H_2$0, ml/cm$H_2$0

15.6 Conversion Factors

1 mbar	equals	0.001	bar
		100	Pa
		1	hPa
		0.1	kPa
		0.75006	torr (760 torr = 1 atm.)
		0.000986	atm
		0.75006	mmHg (at 0 °C)
		0.02953	inHg (at 0 °C)
		1.01974	cmH_2O (at 4 °C)
		0.40147	inH_2O (at 4 °C)
		0.01450	psi, psia
1 bar	equals	1000	mbar
		0.1	Pa
		1000	hPa
		100	kPa
		750.06	torr (760 torr = 1 atm.)
		0.986921	atm
		750.06	mmHg (at 0 °C)
		29.53	inHg (at 0 °C)
		1019.74	cmH_2O (at 4 °C)
		401.47	inH_2O (at 4 °C)
		14.50	psi, psia

MANUAL REVISIONS

Revision #	Revisions Made
Rev 01	Origination
Rev 02	Misc. Edits
Rev 03	Format Updated
Rev 04	Specifications Updated, Misc. Updates

LIMITED WARRANTY

WARRANTY: **BC GROUP INTERNATIONAL, INC.** WARRANTS ITS NEW PRODUCTS TO BE FREE FROM DEFECTS IN MATERIALS AND WORKMANSHIP UNDER THE SERVICE FOR WHICH THEY ARE INTENDED. THIS WARRANTY IS EFFECTIVE FOR TWELVE MONTHS FROM THE DATE OF SHIPMENT.

EXCLUSIONS: THIS WARRANTY IS **IN LIEU OF** ANY OTHER WARRANTY EXPRESSED OR IMPLIED, INCLUDING, BUT NOT LIMITED TO ANY IMPLIED WARRANTY OF **MERCHANTABILITY** OR FITNESS FOR A PARTICULAR PURPOSE.

BC GROUP INTERNATIONAL, INC. IS NOT LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES.

NO PERSON OTHER THAN AN OFFICER IS AUTHORIZED TO GIVE ANY OTHER WARRANTY OR ASSUME ANY LIABILITY.

REMEDIES: THE PURCHASER'S SOLE AND EXCLUSIVE REMEDY SHALL BE: (1) THE REPAIR OR REPLACEMENT OF DEFECTIVE PARTS OR PRODUCTS, WITHOUT CHARGE. (2) AT THE OPTION OF **BC GROUP INTERNATIONAL, INC.**, THE REFUND OF THE PURCHASE PRICE.

NOTES

NOTES

BC GROUP INTERNATIONAL, INC.
3081 ELM POINT INDUSTRIAL DRIVE
ST. CHARLES, MO 63301
USA

1-800-242-8428
1-314-638-3800

www.bcgroupintl.com
sales@bcgroupintl.com

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