## Document History

<table>
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<tr>
<th>Revision History</th>
<th>Date</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rev. 1</td>
<td>6/20/2017</td>
<td>Stefan Frembgen/Michael Bails</td>
</tr>
</tbody>
</table>
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1 ABOUT THE USER’S MANUAL

This User’s Manual is for IngMar Medical’s QuickLung Breather, the Spontaneous Breathing Accessory for the QuickLung Precision Test Lung. It is recommended that you read this instruction manual carefully before using the QuickLung Breather.

This manual is divided into several main sections to help you easily access information and instructions you need.

1.1 Conventions Used in This Manual

- **WARNING!**
  Indicates a potentially harmful condition that can lead to personal injury.

- **CAUTION!**
  Indicates a condition that may lead to equipment damage or malfunction

- **NOTE**
  Indicates points of particular interest or emphasis for more efficient or convenient operation.

**Use of the word “Patient”**
Throughout this manual and in the software, the word “patient” is used to describe a simulated patient with specific lung model settings. This reference corresponds to the use of “patient” in a clinical setting who receives ventilator assistance.

2 SAFETY CONSIDERATIONS

2.1 Operator Safety

For correct and effective use of the product it is mandatory to read and to observe all instructions, WARNINGS, and CAUTION statements in this manual. If the product is not used as instructed, the safety protection provided may be impaired.

2.1.1 Intended Use

The QuickLung Breather is the spontaneous breathing option for the IngMar Medical QuickLung. It may be used in ventilator management training where the need for a spontaneously breathing respiratory simulator is essential while addressing topics of synchrony, patient support, and weaning.
The QuickLung Breather may also be used effectively in ventilator performance verification procedures that require reproducible breath triggers.

IngMar Medical, Ltd. does not recommend any specific ventilator test or calibration procedures and no portion of these instructions shall be construed as doing so.

Always follow ventilator manufacturers’ instructions and recommendations regarding performance verification procedures.

⚠️ **CAUTION!**  
Do not allow aerosols to contaminate the bellows of the QuickLung. Contamination with aerosols may, over time, result in material degradation.

⚠️ **WARNING!**  
Use of the QuickLung Breather in the presence of flammable anesthetics may present an explosion hazard.

⚠️ **WARNING!**  
Electromagnetic Interference: Do not use the QuickLung Breather in patient rooms or other areas where life supporting equipment is in use.
2.2 Summary of General Precautions

**CAUTION!**

Electrical Supply: Connect the power supply provided only to a **properly grounded** wall outlet providing **100 – 240 V AC, 50 – 60 Hz.**

**CAUTION!**

Do not operate QuickLung Breather when it is wet due to spills or condensation. Never sterilize or immerse the device in liquids.

**CAUTION!**

Always use dry air or oxygen with the QuickLung. “Rainout” inside the bellows of the QuickLung may impair its function and may eventually cause damage.

**CAUTION!**

Do not operate the QuickLung Breather if it appears to have been dropped or damaged.

**Warning!**

Fire Hazards related to the use of oxygen:

When using the system with elevated concentrations of oxygen (ventilators set to \(\text{FiO}_2 > 21\%\)), observe all precautions applicable to the use of oxygen indoors.

- Always use extreme caution when using oxygen!
- Oxygen intensely supports any burning!
  No smoking, no open fire in areas where oxygen is in use!
- Always provide adequate ventilation in order to maintain ambient \(\text{O}_2\) concentrations < 24 %.
- Always secure \(\text{O}_2\) cylinders against tipping, do not expose to extreme heat.
- Do not use oil or grease on \(\text{O}_2\) equipment such as tank valves or pressure regulators.
  Do not touch with oily hands. Risk of fire!
- Open and close valves slowly, with smooth turns. Do not use any tools.
3 AN INTRODUCTION TO THE QUICKLUNG BREATHER

3.1 System Overview

The QuickLung Breather acts as a physical “cradle” for the QuickLung (standard or pediatric version “QuickLung Junior”) mounted on top of it.

![QuickLung Breather with Accessories](Image)

Figure 3-1: QuickLung Breather with Accessories

3.2 System Features and Options

The QuickLung Breather offers features and options for the basic as well as the advanced user. The Pulmonary Mechanics Graphics Option (PMG Option) is designed specifically for users that need a graphical representation of flow, pressure and volume waveforms or flow/volume and pressure/volume loops. It operates with an external flow/pressure sensor and can effectively illustrate the interactions between a patient and a ventilator on a personal computer.

Standard features of the QuickLung Breather include:

- The ability to breathe spontaneously, making a small or large contribution to overall minute ventilation
- Predefined breathing patterns include:
  - Eupnea ® (shallow breathing)
  - Cheyne-Stokes ® (periodic breathing)
  - Biot’s ® (groups of quick, shallow inspiration)
  - Kussmaul’s ® (deep and labored breathing)
  - Apneusis ® (deep, gasping inspiration with a pause) at full inspiration
• Apnea - the ability to breathe intermittently, with a preset or randomized ratio of breath to no-breath periods
• The ability to vary breath rate and tidal volume randomly with a mean target of minute ventilation

Please see 6 Using Different Modes of Spontaneous Breathing for further details on the individual modes of spontaneous breathing and the adjustable parameters for each of the different patterns.

4 ASL QUICKLUNG BREATHER SETUP

4.1 Installing the QuickLung

Before attempting to install the QuickLung, ensure that the lift arms on the side of the QuickLung breather are in a downward position.

⚠️ CAUTION!

Make sure that the downward position of the lift arms is not beyond the marking indicated on the side of the QuickLung Breather chassis.

📝 NOTE

If you already own a QuickLung that does not have the side rails or the “wing” panel installed, please contact IngMar Medical to obtain the correct part.

On the rear of the Breather, there is a spring-loaded pin used to secure the QuickLung test lung into place.
• Pull and twist the spring-loaded pin so that the QuickLung can be installed.
• Set the QuickLung onto the Breather by sliding the front of the lung under the Breather locking brackets and lowering onto the Breather surface.
• Release the spring-loaded pin to secure the lung.
4.2 Electrical Connections

The first step for getting started is to establish safe and proper electrical connections following the instructions in this section.

- Connect the DC power output cord of the power supply to the DC input jack in the back of the QuickLung Breather.
- Connect the QuickLung Breather power adapter to line power supplying 100 - 240 V AC, 50/60 Hz with the power cord for your specific country supplied in the package.

**CAUTION!**

Electrical Supply: Connect only to a properly grounded wall outlet providing 100 - 240 V AC, 50 - 60 Hz.

1. Plug DC barrel connector into its socket on the back panel of the QuickLung Breather.
5  RUNNING A SIMULATION

After safely making the electrical connections and installing the QuickLung, you are now ready to run your first simulation.

To begin, turn on the system:

1. Flip the power switch at the back of the QuickLung Breather to the ON ( | ) position.

   ![Figure 5-1: Turning On the Device](image1)

   On the front panel, the LCD display will light up and show the **QuickLung Settings** window.

   ![Figure 5-2: QuickLung Settings Menu](image2)

2. Using the left <+/-> buttons on the front panel, set the **QL Model** to **Adult** or **Junior**, matching the actual QuickLung that is installed on the QuickLung Breather.
3. Using the right <+/-> buttons to set the **Apnea** mode to **Enable** or **Disable**.
4. When complete, press **Mode Select** to continue.
The last setup window appears, where **Resistance** and **Compliance** can be set. Also, the baseline **Offset** value is set for tidal volume accuracy.

![Figure 5-3: Offset and R/C Settings Menu](image)

It is important that the values entered for **Res.** (Resistance) and **Compl.** (Compliance) match the settings of the QuickLung as it is installed. The values are needed to correctly limit spontaneous breathing settings in the different modes.

**CAUTION!**

If the QuickLung Breather is set to take excessive breaths (considering the compliance and/or resistance present), the motor drive will slip and could potentially be damaged.

1. Use the **left <+/->** to match **Res.** to the resistance setting of the QuickLung.
2. Use the **right <+/->** to match **Compl.** to the compliance setting of the QuickLung.

**NOTE on Offset:**

*For correct estimates of the spontaneously inhaled volume, Offset should be adjusted so that, at rest, the lift arms are just touching the “wing” (bracket) from below. This is necessary as the characteristics that make up the QuickLung rubber bellow are not exact. The offset allows the user to create a “zero” position of the lift-arms such that increased accuracy is attained when dialing in a tidal volume.*

3. Use the **center <->** to set the **Offset** value to zero (0),
4. Press **Start/Stop**. This places the lift-arms at the “absolute” zero position.
5. Use **center <->** to increase the **Offset** value, and then press **Start/Stop** again to verify position of the lift-arms. Repeat as necessary until the lift-arms are just touching the QuickLung wing.
6. When complete, press **Mode Select** to cycle through and select one of the pre-defined breath patterns. Use the <+/-> to adjust the settings of each pattern.

7. Press **Start/Stop** to start a simulation with the preselected mode and settings of that mode.

8. The symbol □ then turns into ▶, to indicate the system is running.

**NOTE**

All settings for a particular breath pattern are retained when you switch to a different mode and will be effective again when the original mode is chosen.

The basic patterns available are depicted in the Figure below. For details on using the different modes of breathing patterns, please see the next section of this manual.
6 Using Different Modes of Spontaneous Breathing

The following section describes the different breathing patterns available in the QuickLung Breather, together with the respective ranges of breath rate, I:E-ratio, flow rate, and the maximum spontaneous tidal volume possible.

**Figure 5-6: Eupnea Breathing Pattern Settings**

**NOTE**

Vt indicated in this context is representative only for applications where no PEEP is present that would require the **Offset** to be adjusted, diminishing the maximum available tidal volume.

Generally, high Resistance settings and small Compliance settings limit the range of flow and volume.

<table>
<thead>
<tr>
<th></th>
<th>R = 5 cmH₂O</th>
<th>R = 20 cmH₂O</th>
<th>R = 50 cmH₂O</th>
<th>C = 50 mL/cmH₂O</th>
<th>C = 20 mL/cmH₂O</th>
<th>C = 10 mL/cmH₂O</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. Flow</td>
<td>80 L/min</td>
<td>40 L/min</td>
<td>20 L/min</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max. Vt</td>
<td></td>
<td></td>
<td></td>
<td>720 mL</td>
<td>500 mL</td>
<td>300 mL</td>
</tr>
</tbody>
</table>

For the QuickLung Junior, the respective values are:

<table>
<thead>
<tr>
<th></th>
<th>R = 5 cmH₂O</th>
<th>R = 20 cmH₂O</th>
<th>R = 50 cmH₂O</th>
<th>C = 15 mL/cmH₂O</th>
<th>C = 6 mL/cmH₂O</th>
<th>C = 3 mL/cmH₂O</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. Flow</td>
<td>80 L/min</td>
<td>40 L/min</td>
<td>20 L/min</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max. Vt</td>
<td></td>
<td></td>
<td></td>
<td>215 mL</td>
<td>150 mL</td>
<td>90 mL</td>
</tr>
</tbody>
</table>
6.1 Eupnea

Eupnea is the mode setting with which to simulate “normal” breathing. Wikipedia defines Eupnea as “normal, good, unlabored breathing, sometimes known as quiet breathing or resting respiratory rate. In eupnea, expiration employs only the elastic recoil of the lungs”.

The range of parameters that are available is depicted in the table below:

<table>
<thead>
<tr>
<th>EUPNEA</th>
<th>Rate [BPM]</th>
<th>Volume [mL]</th>
<th>I:E ratio [%]</th>
<th>MV [L]</th>
<th>Insp. Hold [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>QuickLung</td>
<td>4…60 (12)</td>
<td>80…720 (300)</td>
<td>20…80 (33)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>QL Junior</td>
<td>4…60 (20)</td>
<td>24…216 (150)</td>
<td>20…80 (33)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Eupnea mode is very flexible and can be considered a default and starting point for many simulation applications.

6.2 Cheyne-Stokes

Cheyne-Stokes respiration “is an abnormal pattern of breathing characterized by progressively deeper and sometimes faster breathing, followed by a gradual decrease that results in a temporary stop in breathing called an apnea. The pattern repeats, with each cycle usually taking 30 seconds to 2 minutes. [1] It is an oscillation of ventilation between apnea and hyperpnoea with a crescendo-diminuendo pattern”

The range of parameters that are available is depicted in the table below:

<table>
<thead>
<tr>
<th>EUPNEA</th>
<th>Rate [BPM]</th>
<th>Volume [mL]</th>
<th>I:E ratio [%]</th>
<th>MV [L]</th>
<th>Insp. Hold [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>QuickLung</td>
<td>4…40 (12)</td>
<td>200…720 (720)*</td>
<td>Fixed (50)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>QL Junior</td>
<td>4…40 (12)</td>
<td>60…216 (216)*</td>
<td>Fixed (50)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Vmax in a group of breaths

6.3 Biot’s

“Biot's respiration is an abnormal pattern of breathing characterized by groups of quick, shallow inspirations followed by regular or irregular periods of apnea.” [2]

The range of parameters that are available is depicted in the table below:

<table>
<thead>
<tr>
<th>EUPNEA</th>
<th>Rate [BPM]</th>
<th>Volume [mL]</th>
<th>I:E ratio [%]</th>
<th>MV [L]</th>
<th>Insp. Hold [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>QuickLung</td>
<td>12...60*</td>
<td>8...720 (600)</td>
<td></td>
<td>0.1...9.9 (6.0)</td>
<td></td>
</tr>
<tr>
<td>QL Junior</td>
<td>12...40*</td>
<td>24...216 (216)</td>
<td></td>
<td>0.3...2.9 (2.9)</td>
<td></td>
</tr>
</tbody>
</table>

* \(f_{\text{max}}\)

### 6.4 Kussmaul’s

“Kussmaul breathing is a deep and labored breathing pattern often associated with severe metabolic acidosis, particularly diabetic ketoacidosis (DKA) but also kidney failure. It is a form of hyperventilation, which is any breathing pattern that reduces carbon dioxide in the blood due to increased rate or depth of respiration.”[^3]

The range of parameters that are available is depicted in the table below:

<table>
<thead>
<tr>
<th>EUPNEA</th>
<th>Rate [BPM]</th>
<th>Volume [mL]</th>
<th>I:E ratio [%]</th>
<th>MV [L]</th>
<th>Insp. Hold [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>QuickLung</td>
<td>18...60</td>
<td>200...720 (720)</td>
<td>40...60 (50)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>QL Junior</td>
<td>18...60</td>
<td>60...216 (216)</td>
<td>40...60 (50)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 6.5 Apneusis

“Apneustic respiration (a.k.a. apneusis) is an abnormal pattern of breathing characterized by deep, gasping inspiration with a pause at full inspiration followed by a brief, insufficient release.”[^4]

The range of parameters that are available is depicted in the table below:

<table>
<thead>
<tr>
<th>EUPNEA</th>
<th>Rate [BPM]</th>
<th>Volume [mL]</th>
<th>I:E ratio [%]</th>
<th>MV [L]</th>
<th>Insp. Hold [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>QuickLung</td>
<td>4...40 (12)</td>
<td>80...720 (450)</td>
<td>60...75*</td>
<td></td>
<td>20...50 (25)</td>
</tr>
<tr>
<td>QL Junior</td>
<td>4...40 (20)</td>
<td>24...216 (150)</td>
<td>60...75*</td>
<td></td>
<td>20...50 (25)</td>
</tr>
</tbody>
</table>

* set by algorithm

[^3]: Wikipedia.org
[^4]: Wikipedia.org
6.6 Using the Apnea Feature

You can control how apnea enters into the breathing patterns of your simulated patient by selecting the number of breaths taken (Breaths) and omitted (NoBr). Additionally, you can enter quasi-randomization into the pattern for more realism. Randomization takes the values of Breaths and NoBr as median values and allows the actual number of breaths taken and omitted over time to vary in the range of +/-30%. A seed value for the random number generator starts the pattern. The quasi-random apnea pattern can thus be repeated based on the set Seed value. Numbers between 1 and 999 are allowed. Setting the Seed value to zero (0) forces the QuickLung Breather to use the set Breaths and NoBr as fixed values, without any random fluctuations.

If Apnea is enabled at startup in the QuickLung Settings window, the Apnea Settings window will appear when Mode is pressed.

![Figure 6-1: QuickLung Settings Menu](image)

1. Set the (median) value of the number of breaths that you want your patient to take before an apnea occurs.
2. Set the (median) value of the number of breaths for which you want your patient to make no effort (duration of the apnea).
3. Adjust the Seed value to either 0 (no randomization) or a different number for randomization.
4. When complete, press Mode Select button to continue.
5. When Apnea is active in any of the breath patterns, it is indicated by the letter A in the top right corner of the display.
7 SUPPORT

7.1 Support Resources

Recognizing that the QuickLung Breather has users from a large number of specialties, IngMar Medical is dedicated to support its users in many different ways.

We encourage you to visit our website at www.ingmarmed.com as the entry point for up-to-date information on support options. While the primary source of user information is this User’s Manual, there are a number of other resources for additional support.

Updated editions of this User’s Manual can be downloaded from the IngMar Medical website.

7.2 Frequently Asked Questions (FAQs)

For a list of answers to FAQs, please check IngMar Medical’s website here:


For questions more directly related to the QuickLung Breather only, go to:

7.3 Troubleshooting

Here are a few conditions (with their solutions) that you can easily identify and troubleshoot:

- Lift arms are moving in the wrong direction

  Solution: while QuickLung Breather is not operating, position the lift arms so that they are above the line marked on the sides of the device.

  Figure 7-1: QuickLung Settings Menu

**WARNING!**

Do not interfere with the movement of the lift arms while the device is operating. Personal injury might result.

- Device makes loud “ratcheting” noise when operating.

  Cause: Likely, the settings for compliance and/or resistance were not matched to the physical settings of the installed QuickLung and the drive is forced to perform under extreme load.

  Solution: Stop operation, go to Offset and R/C Settings Menu (see Figure 5-3) and enter the correct values.
8 MAINTENANCE

When inquiring about maintenance, always have the serial number of your device available. Additional reference information can be found on the label on the bottom of the instrument a copy of which is included also in the product binder supplied which each instrument.

**CAUTION!**

The QuickLung Breather does not contain user-serviceable components or parts. Unauthorized opening of the device will void the warranty.

For details about available service subscriptions or extended warranty plans, please contact IngMar Medical Customer Care at

1 (800) 683-9910, or +1 (412) 441-8228 ext. 127

or e-mail to support@ingmarmed.com
9 TECHNICAL DATA

9.1 Performance Specifications

Volumes

Total Volume (QuickLung) 1.2 L (400mL for Junior)
Spontaneous Tidal Volume 0 to 720 mL (0 to 215 mL for Junior)

Frequencies

Spontaneous Breath Rate 4 to 60 BPM based on breath pattern

Flows

Peak Flow 80 L/min

Lung Settings

Resistance 5, 20, 50 cmH₂O/L/s
Compliance 50, 20, 10 mL/cmH₂O (15, 6, 3 mL/cmH₂O for Junior)

9.2 Electrical Specifications

Power Requirements Universal input 100 to 240 V AC, 50/60 Hz
DC Output 24 V 3.0A
### 9.3 Physical Specifications

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>QuickLung with Wing</td>
<td>11” x 8.5” x 2.25” (276.4 x 215.9 x 57.2 mm)</td>
</tr>
<tr>
<td>QuickLung with Breather</td>
<td>14” x 8.5” x 6.5” (355.6 x 215.9 x 165.1 mm)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Weight</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>QuickLung Breather</td>
<td>Approx. 22 lbs. (10 kg)</td>
</tr>
<tr>
<td>QuickLung</td>
<td>3.5 lbs. (1.6 kg)</td>
</tr>
</tbody>
</table>

**Materials Used**

**Inside the QuickLung Precision Test Lung**

- Bellows: Hypalon®, Stainless Steel
- Bellow End Plates: Aluminum, Silicone Sealant
- Connector: Delrin

### 9.4 Environmental Specifications

<table>
<thead>
<tr>
<th>Storage</th>
<th>Temperature: -10 ºC to 50 ºC</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(allow device to reach approximate room temperature before use)</td>
</tr>
<tr>
<td></td>
<td>Humidity: 10 to 95%, non-condensing</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Operation</th>
<th>Temperature: +10 ºC to 40 ºC</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Humidity: 10 to 95%, non-condensing</td>
</tr>
</tbody>
</table>

Specifications are subject to change without notice.
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