TekMedika

TekMedika Pvt. Ltd.

INSPIRE-100

A Streamlined Emergency Respiration Assist Device

INSPIRE-100
(Patent Pending)

Is it right for you?

- *Need adult respiratory support?*
- *Budget Friendly?*
- *Support from Initiation to Weaning?*
- *No compressed air or piped Oxygen?*
- *Connect to O_2 Cylinder or Concentrator?*
- *Full range of Respiration parameters?*
- *Breath Synchronization for Patient Comfort?*
- *Remote monitoring capability?*
- *Handle harsh-uncontrolled Environment?*
- *Easy-to-use System?*

NO PROBLEM!

Setting the Context

The Motivation

The Problem Statement

Respiration Assist Devices

Categories – Usage and Pricing

Features

Less than Rs 50,000

CPAP

Less than Rs 1 Lakh

BiPAP

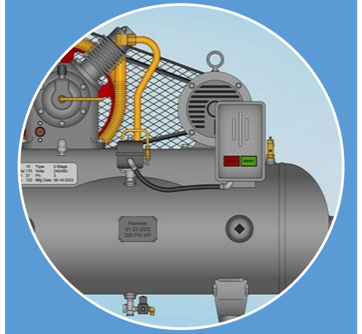
AFFORDABLE feature set for PHC, Small Clinic, and Ambulance Use?

Big Hole

Rs 12 Lakhs ++

ICU Ventilator

Evolution of Ventilators



Iron Lung Age

Pneumatic Age

µController Age

Smart "E"-Age

Most-used Ventilation Modes have not changed

- Volume and Pressure Control
- Control BPM, I/E, VT and PS
- Monitor pressures and flow
- Safety Alarm systems

Diminishing Returns from what has evolved …

- Exotic Ventilation modes
- Multitude of Sensors
- Fancy Touch-screen LCD Displays

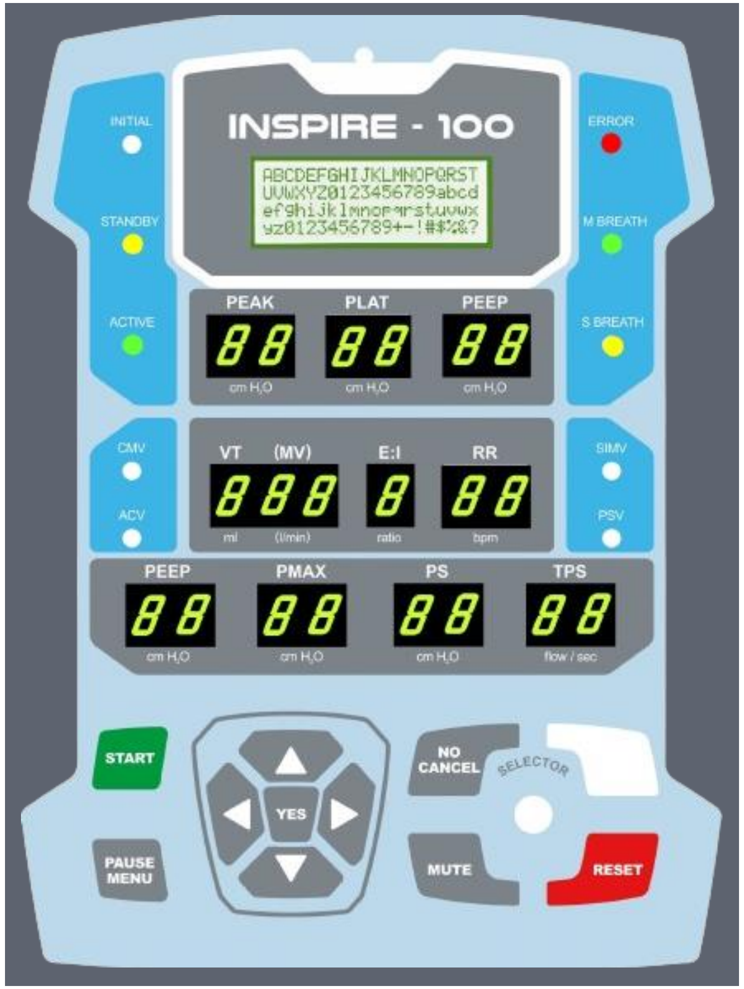
INSPIRE-100 Details

System Components

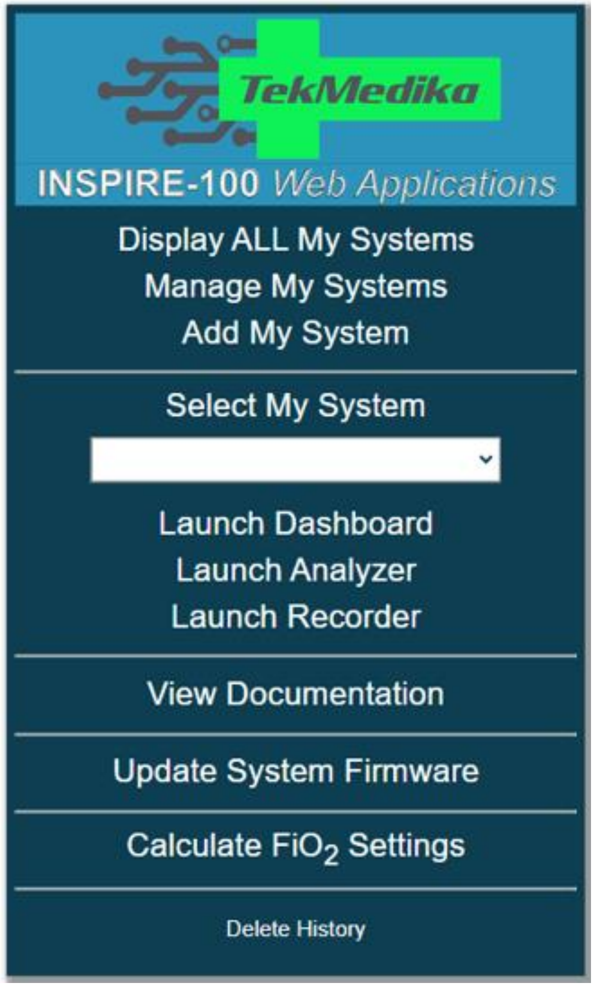
Technical Details

Elegance in Simplicity

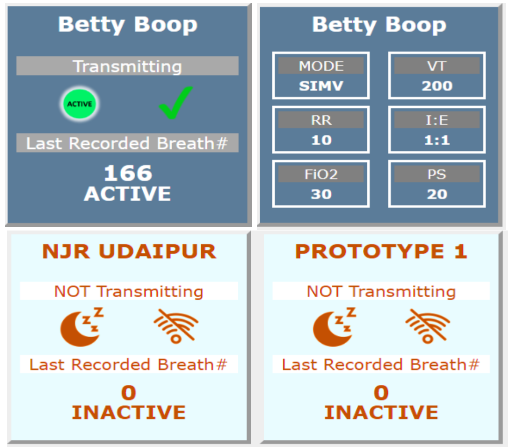
Menu-driven, Tactile, Intuitive and Easy-to-read Control Panel



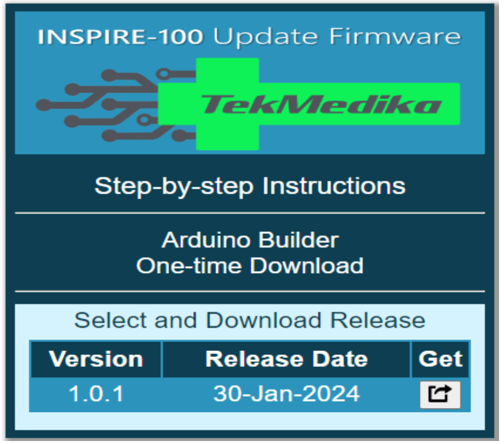
Live Dashboard Recording and Analyzer



Multi-system Dashboard for Nurses' Station



Field Upgradeable



Product Overview

Salient Features

Exceptionally Budget Friendly

Elaborate Remote Monitoring Capabilities

Easy-to-use
Easy-to-train
Rugged & Robust

No Need for Compressed air or Piped O_2

Complete Set of Most-used Respiration Parameters

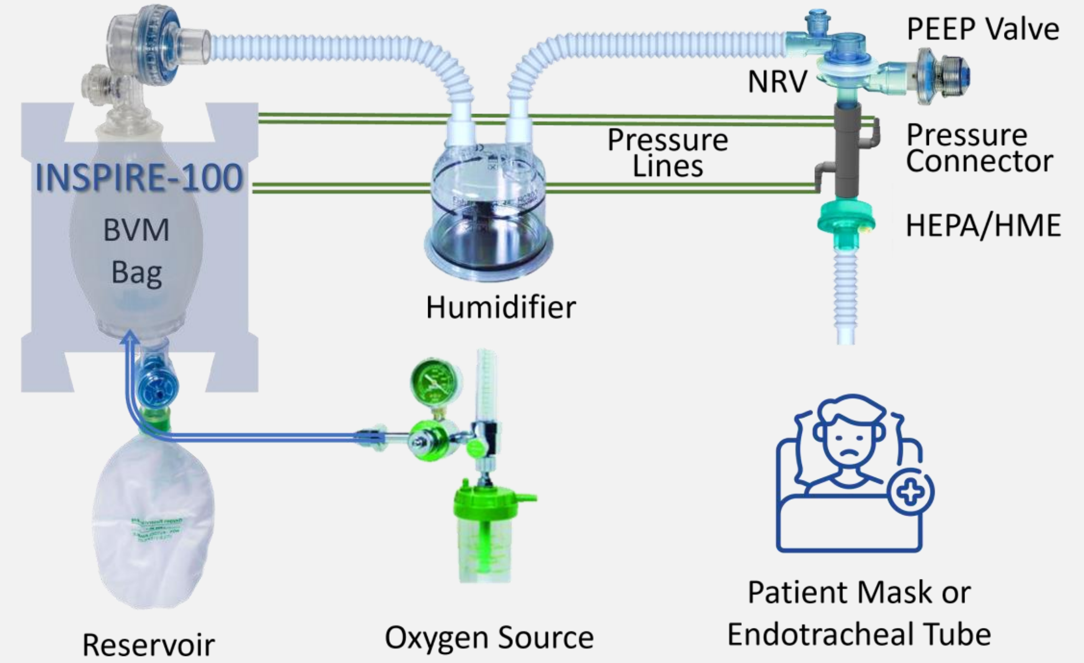
Power Consumption 100W

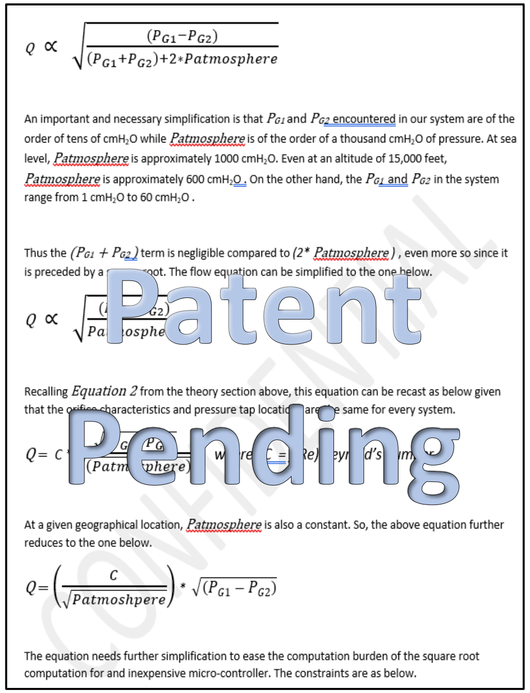
Patient Comfort

Mandatory Breaths synchronized with Patient-initiated Breaths

No breath stacking

Breathing Circuit





$$Q \propto \sqrt{\frac{(P_{G1}-P_{G2})}{(P_{G1}+P_{G2})+2*Patmosphere}}$$

An important and necessary simplification is that P_{G1} and P_{G2} encountered in our system are of the order of tens of cmH_2O while *Patmosphere* is of the order of a thousand cmH_2O of pressure. At sea level, *Patmosphere* is approximately 1000 cmH_2O. Even at an altitude of 15,000 feet, *Patmosphere* is approximately 600 cmH_2O . On the other hand, the P_{G1} and P_{G2} in the system range from 1 cmH_2O to 60 cmH_2O .

Thus the $(P_{G1} + P_{G2})$ term is negligible compared to $(2* Patmosphere)$, even more so since it is preceded by a [illegible]oot. The flow equation can be simplified to the one below.

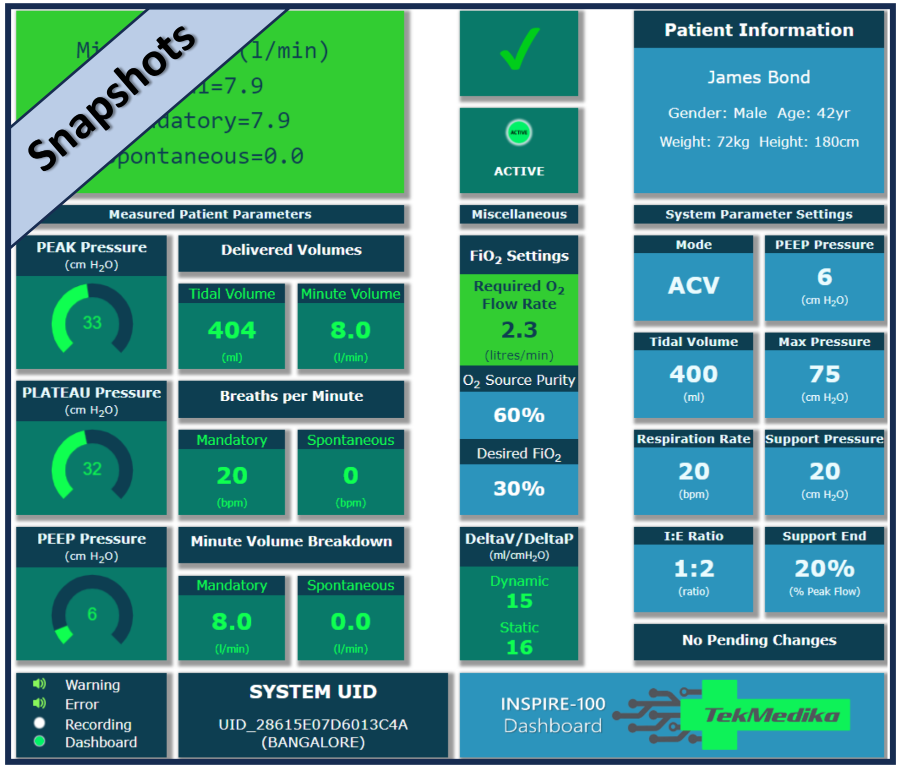
Recalling *Equation 2* from the theory section above, this equation can be recast as below given that the [illegible] characteristics and pressure tap locati[illegible] are [illegible]e same for every system.

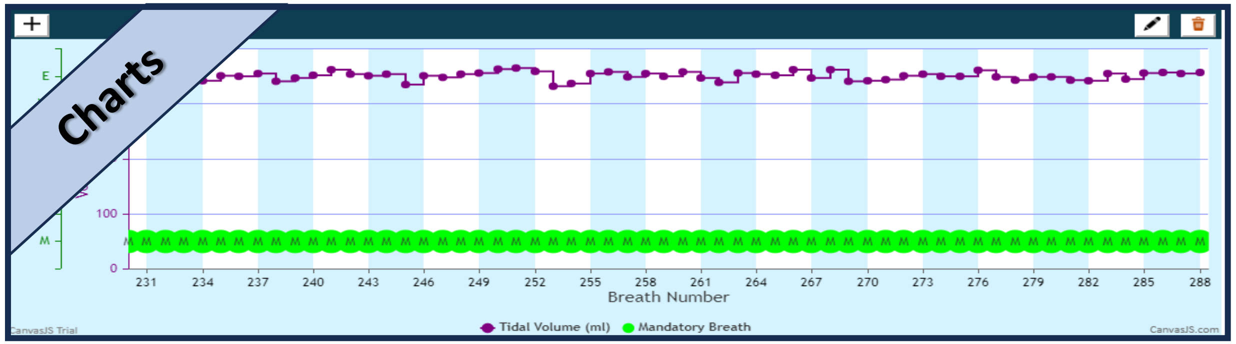
At a given geographical location, *Patmosphere* is also a constant. So, the above equation further reduces to the one below.

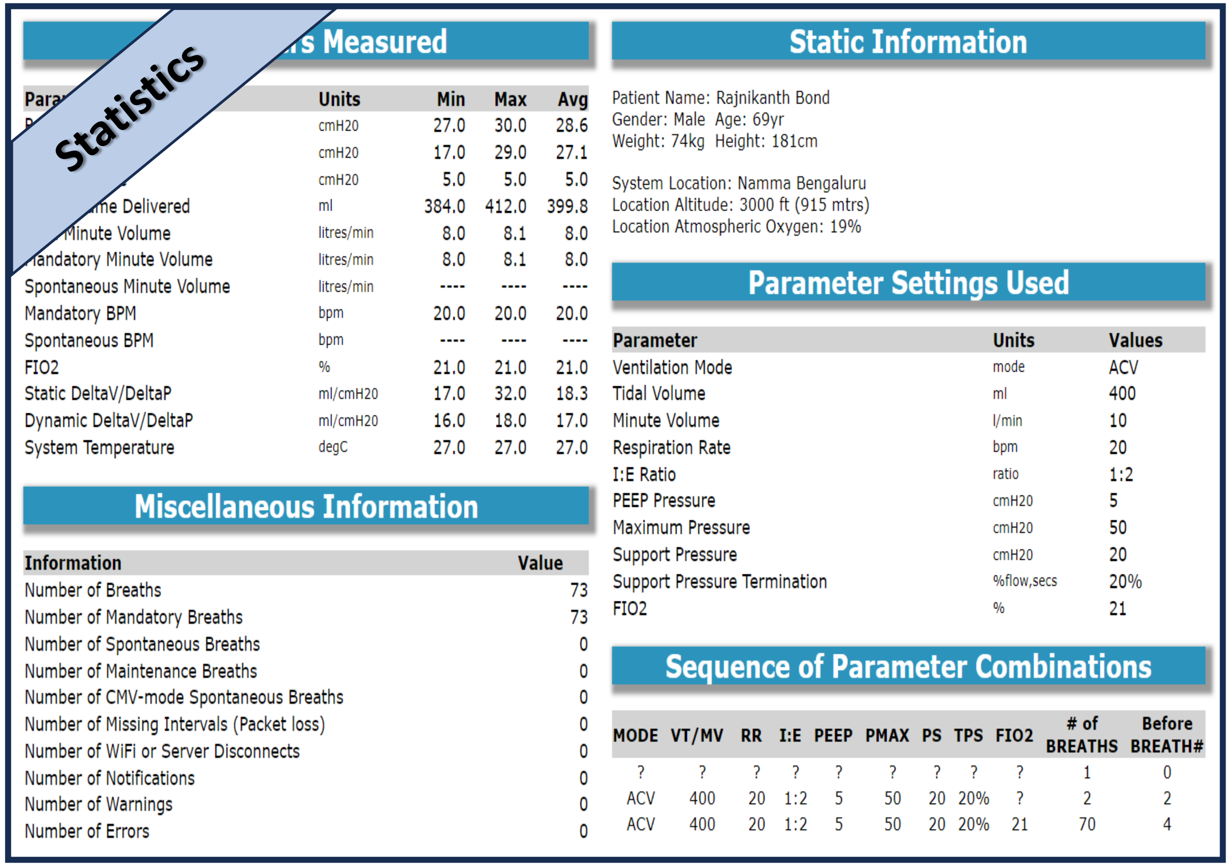
$$Q = \left(\frac{C}{\sqrt{Patmoshpere}}\right) * \sqrt{(P_{G1} - P_{G2})}$$

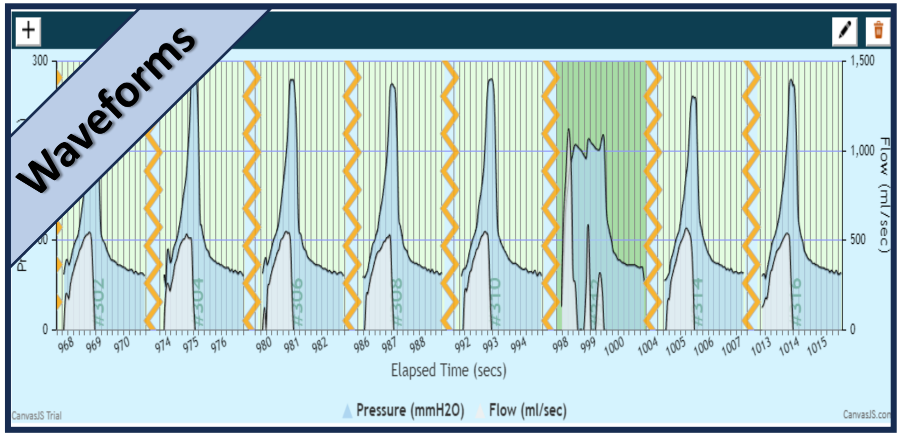
The equation needs further simplification to ease the computation burden of the square root computation for and inexpensive micro-controller. The constraints are as below.

Elaborate Remote Monitoring









Technical Specifications

Commonly used Ventilation Modes

CMV	Continuous Mandatory Ventilation
ACV	Synchronized Assist Control Ventilation
SIMV	Synchronized Intermittent Mandatory Ventilation
PSV	Pressure Support Ventilation

Full Set of Alarm Alerts

Max Pressure	Pressure Leak	Pressure Loss
Airway Blockage	Coughing Hiccupping	Inconsistent Parameters
Extreme Parameter Combination	System Temperature	And many more …

Volume Controlled Breaths

Tidal Volume **200 - 600 ml**	***Respiratory Rate*** **10 - 30 bpm**	***I:E Ratio*** **1:1 1:2 1:3**
PEEP **4 - 15 cmH_2O**	***Max Pressure*** **15 - 60 cmH_2O**	***FiO_2 Support*** **System Managed** **Externally Controlled**

Pressure Supported Breaths

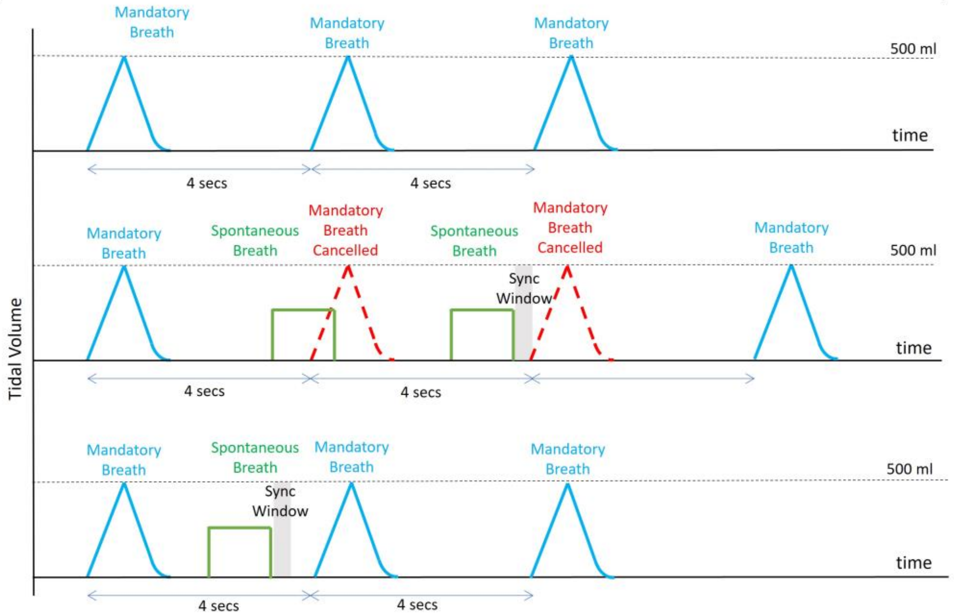
Support Pressure	5 - 35 cmH_2O
Support Pressure Termination	Flow Triggered Time Triggered

Synchronize Mandatory breaths with Spontaneous breaths
Prevent breath stacking

Breath Syncing in SIMV mode

There is a sync-window – the next mandatory breath is rescheduled only if spontaneous breath within the sync-window

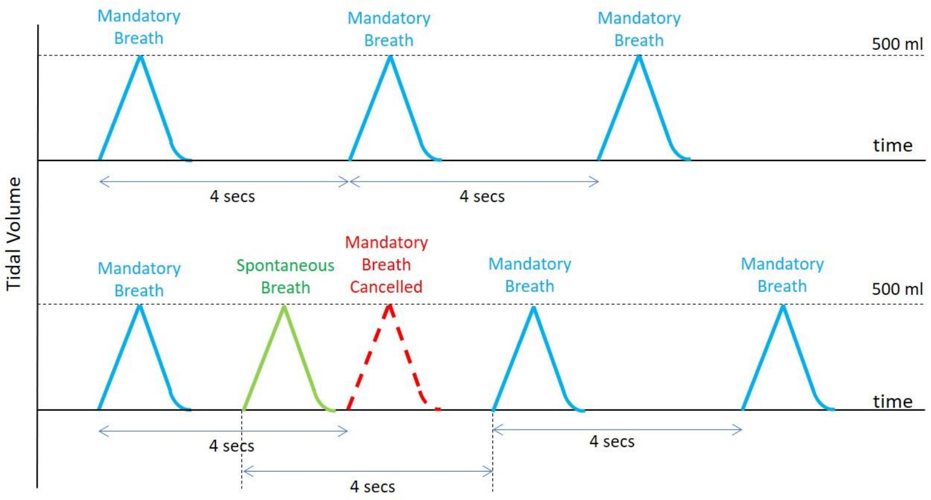
Example below: Tidal Volume = 500ml Respiration Rate = 15 bpm



Breath Syncing in Synchronized AC Mode

There is no sync-window – the next mandatory breath is always rescheduled after a spontaneous breath

Example below: Tidal Volume = 500ml Respiration Rate = 15 bpm



FiO_2 Settings

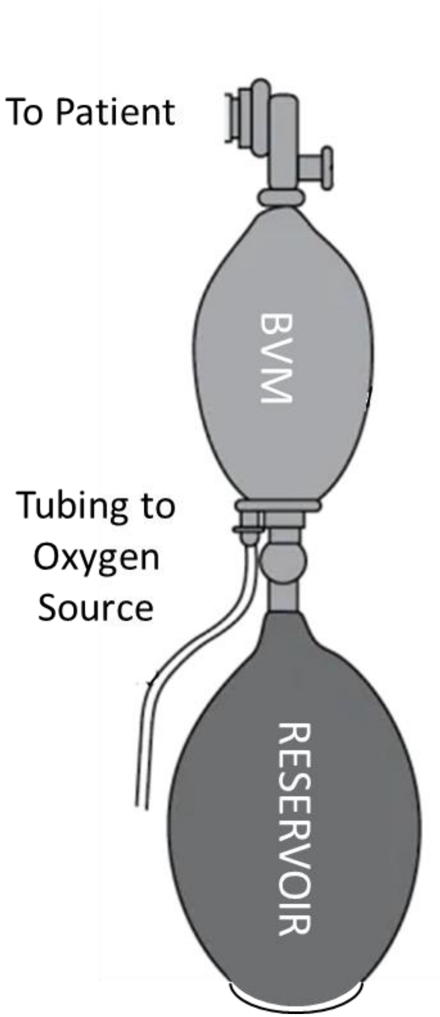
Without the Reservoir bag, FiO_2 delivered is the Atmospheric O_2 content at site

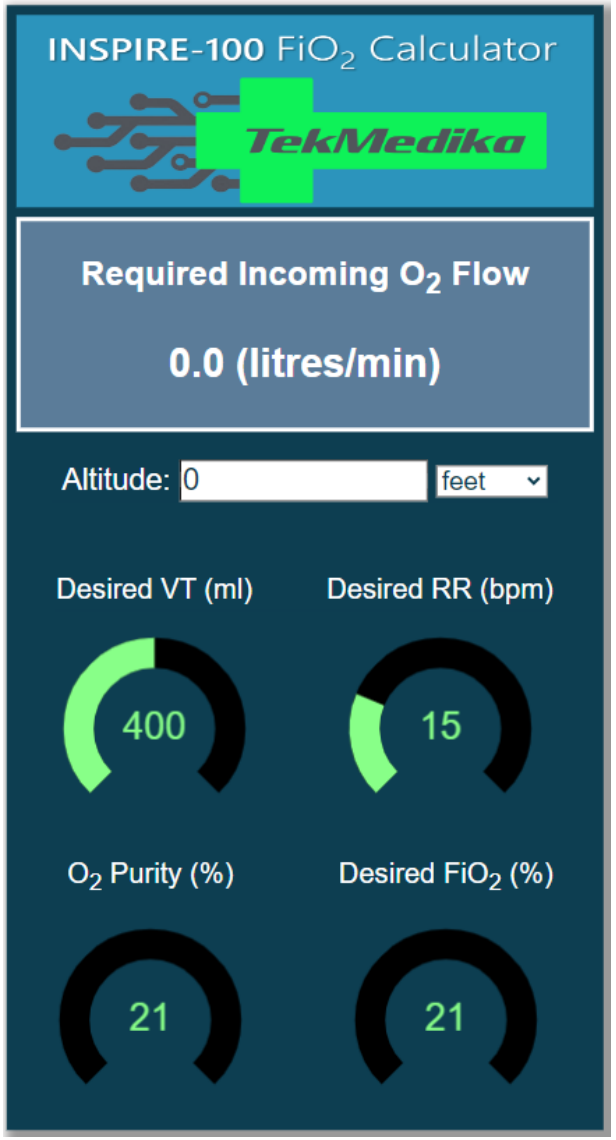
FiO_2 delivery with the Reservoir bag is mathematically modelled, calibrated and verified in the Lab to provide +/- 5% accuracy

Front-panel guides the user in setting the appropriate input O_2 flow rate from the O_2 source for a given FiO_2

The mathematical model provides for a possible O_2 concentrator as an O_2 source (purity < 100%)

Online Web-accessible FiO_2 calculator is also provided for exploration purposes





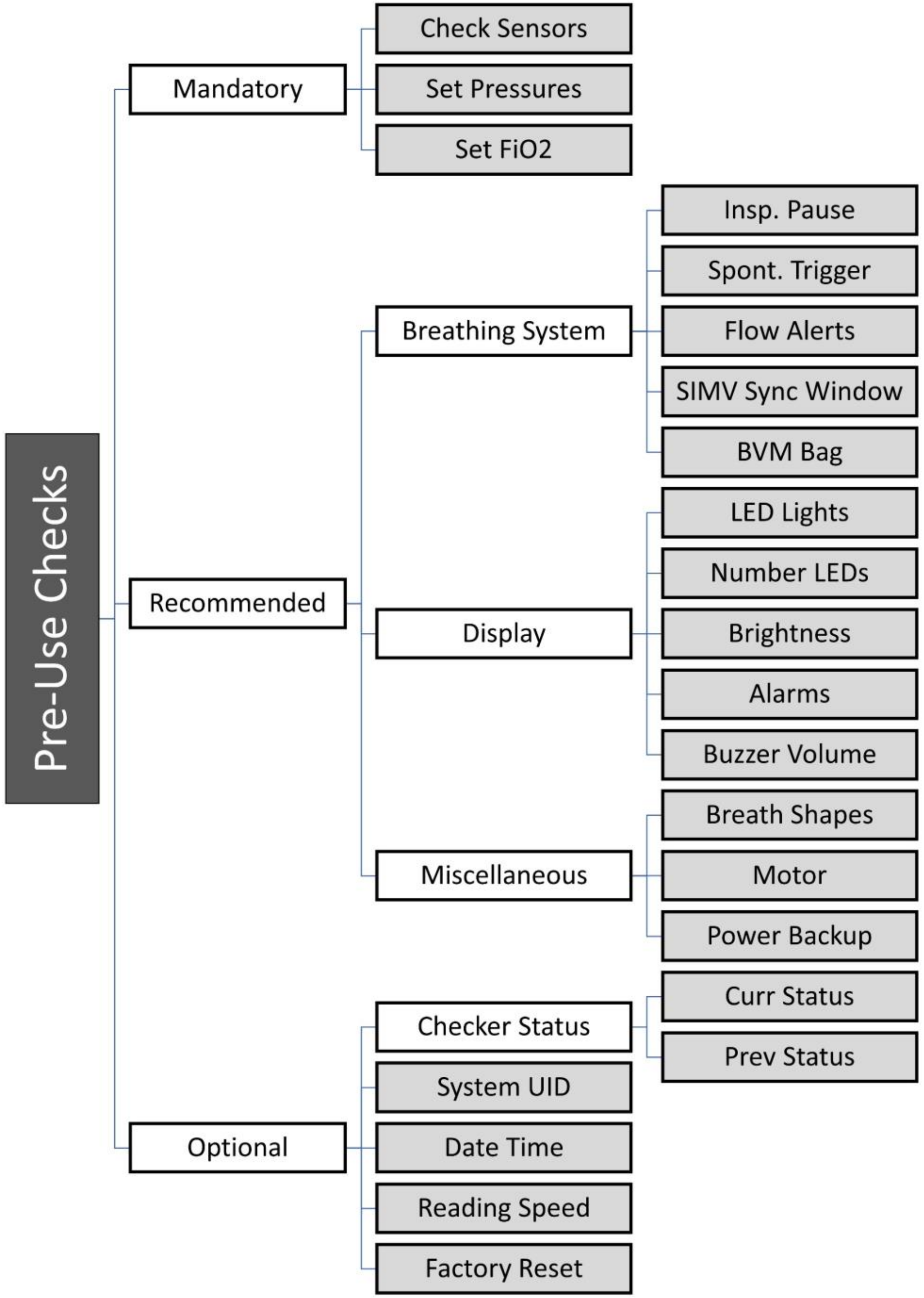
Alarms & Safety Features

Enforcement of Pre-use checks

Maintenance Breaths till Alarm situation rectified

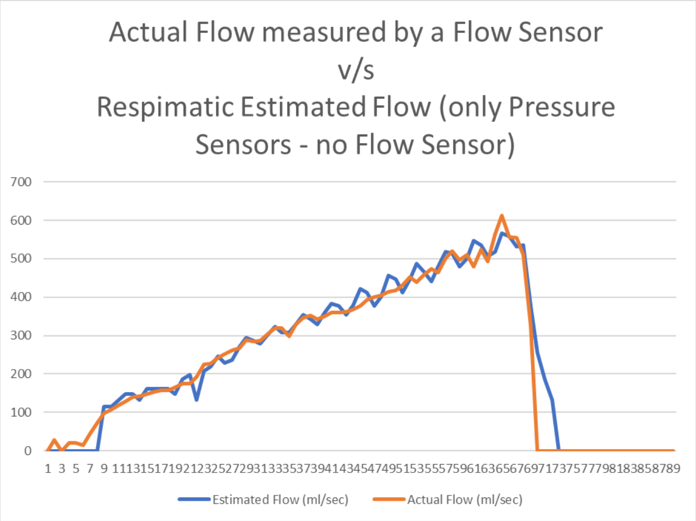
Alarms, Warnings and Notifications

- Max Pressure Alarm
- Pressure Leak Alarm
- Pressure Loss Alarm
- Airway Blockage Alarm
- System Temperature Alarm
- Sensor Failure Alarm
- Breathing Circuit Failure Alarm
- Detect coughing/hiccupping fits
- Inconsistent input parameters
- Extreme parameter combination warnings
- And many more …



Backup

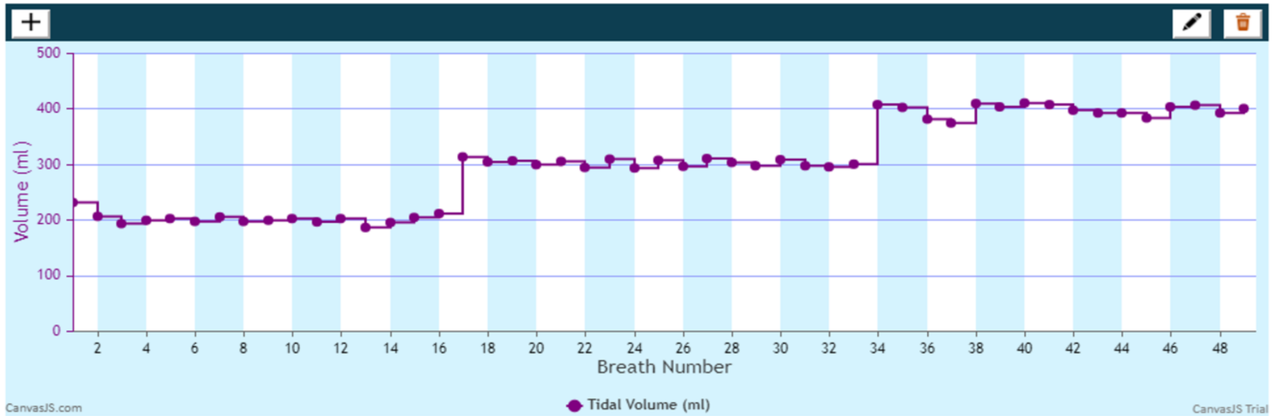
Some Results



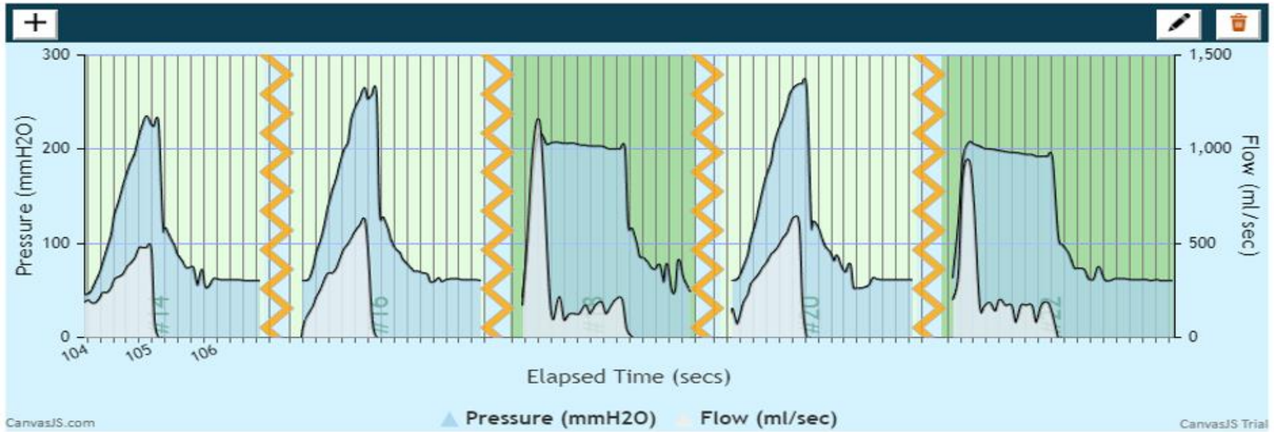
Sample FiO2 Data

PEEP=6,EI=2			Measured	Calculated	ERROR
VT	RR	O2 (l/min)	FiO2(%)	FiO2(%)	%
400	20	2	40.5	39	4%
400	20	2.5	45.5	43.5	4%
400	20	3	49	48	2%
400	20	3.5	54	53.5	1%
400	20	4	59.8	57	5%
400	20	4.5	63.5	61.5	3%
400	20	5	67.5	66	2%
400	30	2	33	33	0%
400	30	2.5	36.5	36	1%
400	30	3	38.5	39	1%
400	30	3.5	41.5	42	1%
400	30	4	44.5	45	1%
400	30	4.5	47.1	48	2%
400	30	5	49.8	51	2%

VT Titration for VT = 200, 300 and 400ml



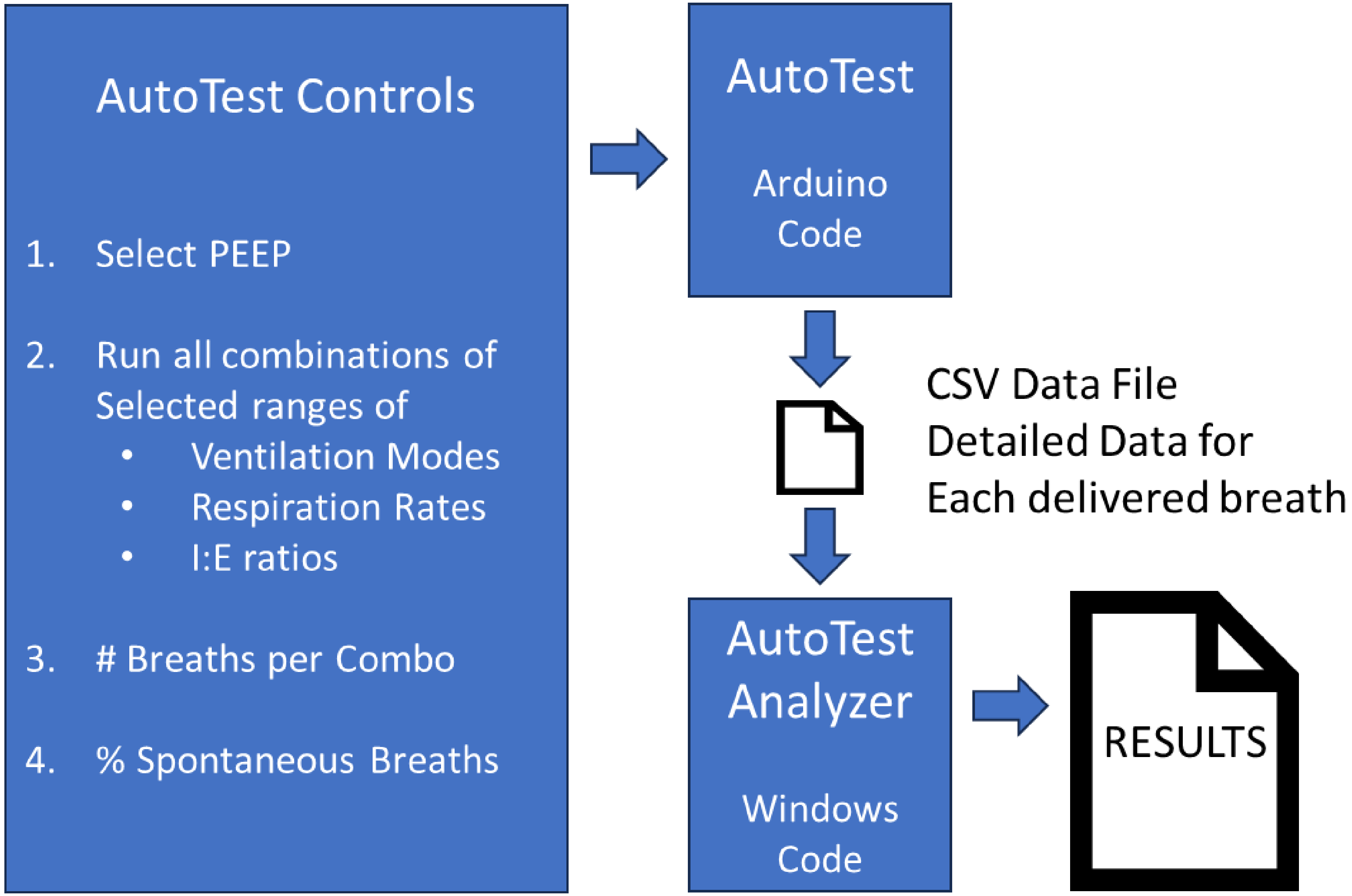
A Mix of VC and PS Breaths



CPAP *v/s* BiPAP *v/s* INSPIRE-100 *v/s* ICU-VENTILATOR

CPAP	BiPAP	Respimatic 100	ICU Ventilator
Continuous Positive Airway Pressure	Continuous Bi-Level Airway Positive Pressure	Mechanical Ventilation with 4 most-used ventilation modes and controls	Mechanical Ventilation with very sophisticated modes and controls
Non-invasive	Non-invasive	Non-invasive + Invasive	Non-invasive + Invasive
High Flow + PEEP	Inspiratory Pressure + PEEP	Tidal Volume + Support Pressure + PEEP	Tidal Volume + Support Pressure + PEEP
Useful for Type 1 respiratory Failure (Hypoxemic)	Useful for Type 2 respiratory Failure (Hypercopnic)	Useful for Hypoxemic and Hypercopnic respiratory failure	Useful for Hypoxemic and Hypercopnic respiratory failure
Continuous flow of air at a constant pressure. Increases mean airway pressure to recruit collapsed alveoli	Continuous flow of air at different constant pressures during inspiration and expiration breathing phase	Independent control over the volume, the respiration rate and pressure	Independent control over the volume, the respiration rate and pressure
Useful only when patient can breathe on his own	Useful only when patient can breathe on his own	Useful when patient can or CANNOT breathe on his own	Useful when patient can or CANNOT breathe on his own
Only Spontaneous breaths that are patient triggered.	Only Spontaneous breaths that are patient triggered.	Spontaneous breaths + Mandatory breaths controlled by RR and I:E	Spontaneous breaths + Mandatory breaths controlled by RR and I:E
External FiO2 control	External FiO2 control	System assisted FiO2 control	Direct FiO2 control
Breath Synchronization N/A	Breath Synchronization N/A	Full Breath Synchronization	Full Breath Synchronization
No Tidal Volume control	Indirect Tidal Volume control (IPAP-EPAP)	Direct Tidal Volume control	Direct Tidal Volume control
No Respiration Rate control	No Respiration Rate control	Direct Respiration Rate control	Direct Respiration Rate control
No Inspiration:Expiration ratio control	No Inspiration:Expiration ratio control	Direct Inspiration:Expiration control	Direct Inspiration:Expiration control
External Humidity control	External Humidity control	External Humidity control	Direct Humidity control
No display of Peak, Plateau or PEEP	No display of Peak, Plateau or PEEP	Full display of Peak, Plateau and PEEP	Full display of Peak, Plateau and PEEP
Minimal alarm signals	Minimal alarm signals	Full set of Alarm signals	Full set of Alarm signals
No remote monitoring	No remote monitoring	Sophisticated Remote WEB Dashboard	Minimal Remote monitoring (if any)

Automated Testing



Thank you