Portable Emergency Ventilator Phase II

Team: P13027

A Portable Emergency Ventilator (PEV) is a device that can provide positive pressure ventilation to a person who is incapable of breathing on their own. This project focuses on improving a PEV developed in the late 1980s by Jeff Gutterman and Roman Press and the latest model as developed by MSD Group P13026. The goal of this project is to update the previous models using modern day technologies. This will focus on making it smaller, lighter, and more usable, while providing effective functionality and provide familiar feedback to the user. The expected end result of the project was a functional prototype which can be marketed to companies and manufactured by 2015.

Project Website
https://edge.rit.edu/edge/P13027/public/Home

Project Advisors

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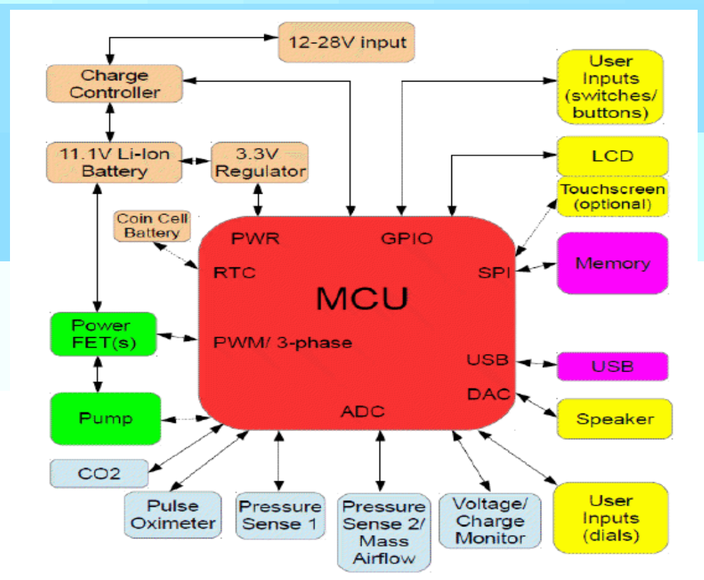
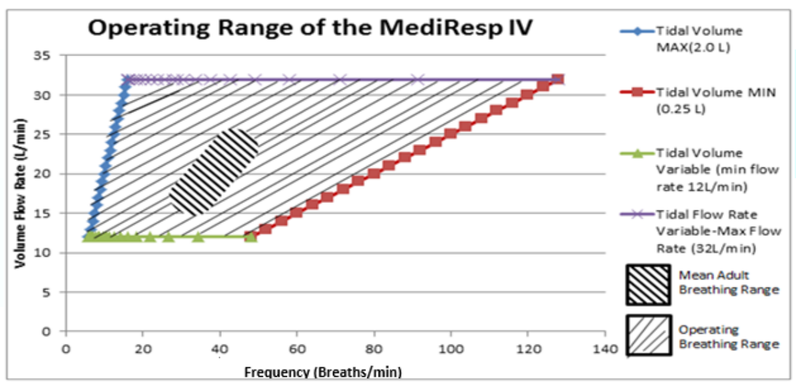
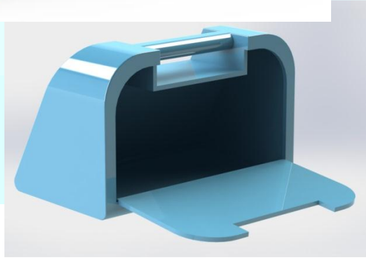
System Operation





Customer Needs

Customer Need #	Importance	Description	Comments/Status
CN1	1	Maintain Portability	Portable based on digital electronics, preferably on microprocessor, minimize weight and size
CN2	1	Include Audio Feedback	Gives non-visual, non-braille instructions/feedback
CN3	1	Optimize Battery Life	Operates for minimum of 2 hours without recharging
CN4	1	Replaceable Battery	Battery easily replaced
CN5	1	Minimize Expenses	Parts cost < $1000
CN6	1	Display Relevant Data	Show information that will be necessary for the customer to operate the ventillator on the front panel
CN7	2	Measure Oxygen Levels	Add a pulse oximeter
CN8	2	Measure CO_2 Levels	Measure CO_2 levels on expiration
CN9	2	Optimize for mass production	
CN10	3	Design Similarly	The design of an updated version of the PEV that remains "substantially equivalent" to the design which received FDA 510(k) approval to manufacture and market
CN11	3	Record and Transfer Data	Record and transfer data
CN12	3	Reduce size/weight	(less than 18lbs)



Concept Realization

Engineering Specifications

Specification Number	Importance	Source	Function	Specification (Metric)	Unit of Measure	Marginal Value	Comments/Status	Test Plan	Concluded Condition
S1	1	PRP	System	Volume Control	Liters	0.2 ± 0.2		S1 Test Plan	O
S2	1	PRP	System	Breathing Rate	BPM, Breaths per Minute	4-15		S2,S3,S5 Test Plan	O
S3	1	PRP	System	Flow Rate	Liter/Min	15-60		S2,S3,S5 Test Plan	Δ
S4	1	PRP	System	Air Assist Sensitivity	cm H20	0.5± 0.5		S4 Test Plan	O
S5	1	PRP	System	Pressure Control	cm H20	10-70		S2,S3,S5 Test Plan	Δ
S6	1	PRP	System	DC Input	Volts	6-16	Due to battery, must be greater than 9V	S6 Test Plan	O
S7	1	PRP	System	DC Internal Battery	Volts	12		Per data Sheet	O
S8	1	PRP	System	Internal Battery Life	Hours	> 2		S8-a and S8-b Test Plan	O
S9	1	PRP	System	Elasped Time Meter	Hours	0-8000		Per data Sheet	O
S10	1	PRP	System	Pump Life	Hours	4500		Per data Sheet	O
S11	1	PRP	System	O2/Air Mixer	% of O2	21%-100%		Per data Sheet	O
S12	1	PRP	System	Secondary Pressure relief	cm H20	75		S12 Test Plan	Δ
S13	1	PRP	System	Timed Back up BPM					O
S14	1	PRP	System	Weight	kg	≤ 8		S14 Test Plan	O

KEY	
X	Does not meet expectation
Δ	Caution-Undetermined if specification is met
O	Meets specification

Testing

In order to ensure our system met the engineering specifications laid out by our customer, test plans were developed to produce results conclusive of proper functionality.

- Battery life tests were performed to characterize Battery performance
- Pump functionality was evaluated to ensure our system could meet the standards set by the customer for breathing rate, flow rate, and pressure control
- Pressure sensor testing was performed to characterize the static pressure sensors according to the mechanical pressure gauge.

Results and Conclusions

Fully functional prototype

- Simplified Custom PCB design reduces weight and production cost
- Redesigned housing and user interface is more user-friendly
- Fully programmed system can operate in four modes
  - Continuous Mandatory Ventilation (CMV)
  - Air Assist
  - Manual
  - CPR
- Overall reduction in weight and volume of product increases portability
- Improved battery life over 4 hours

Design meets FDA approvals
Design meets customer needs

Future Improvements

- Improved ergonomics and durability of enclosure
- Improved mechanical relief system
- More powerful pump to achieve a larger operating range
- A second revision of the circuit board to correct errors found in initial design

Left to Right: Matt Burkell (Electrical Engineer), Paulina Klimkiewicz (Mechanical Engineer), Megan O'Connell (Mechanical Engineer), Steve DiGerardo (Mechanical Engineer), Jake Leone (Mechanical Engineer), David Herdzik (Electrical Engineer)