



Miniature Modular Rack Launcher Combo



Senior Design Group 3

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Overview

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- Conclusion/Next Steps

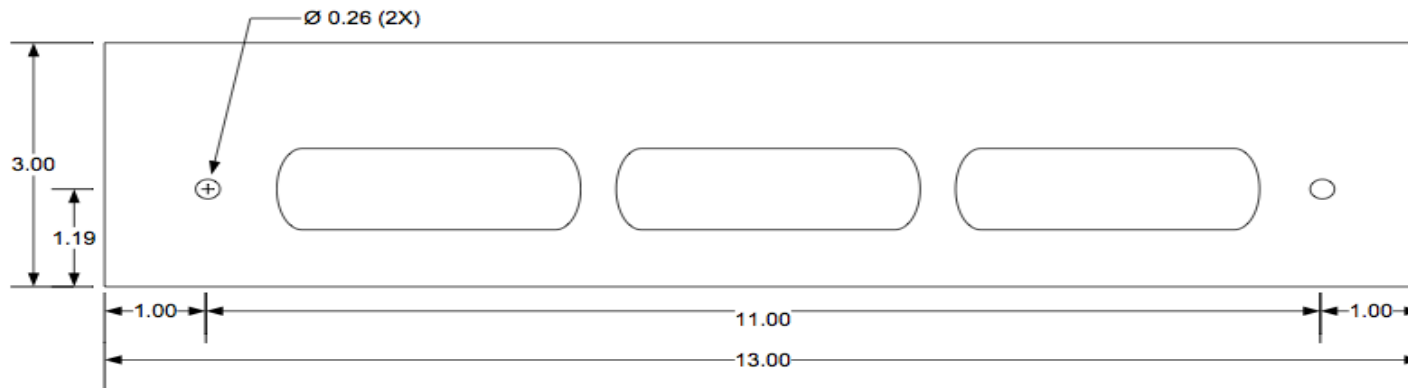
Problem Statement

- Design and develop a Bomb Rack Unit (BRU) that is attached to the Tigershark UAV capable of housing and launching a cylindrical payload.
- BRU must contain an electrical interface that allows the user to go through a safety sequence before the payload is released
- Provide budget analysis for MMRLC
- Prototype and fit check

Tigershark UAV Platform

Specifications:

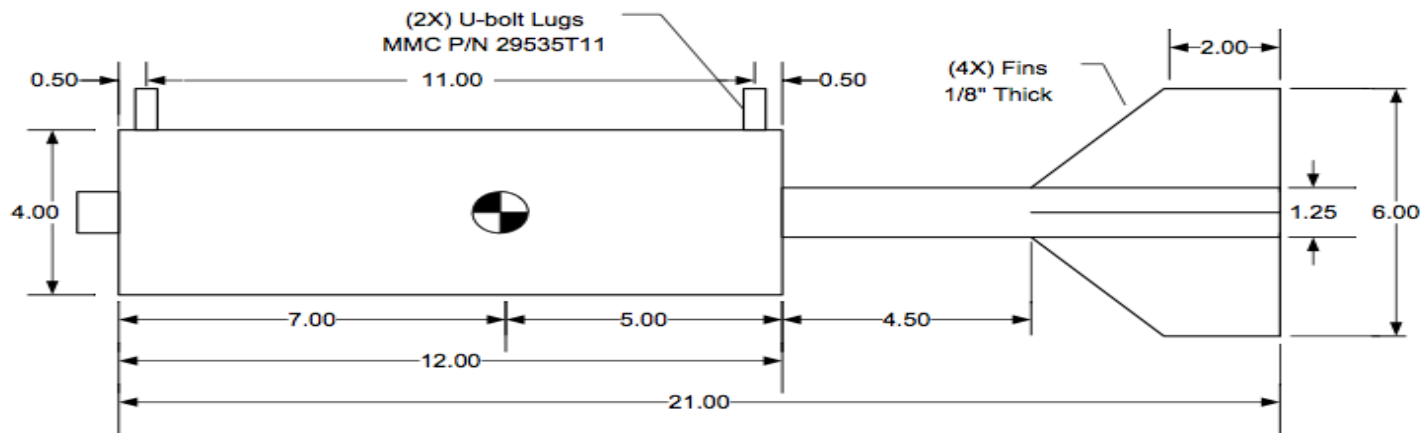
- Wing span 21 feet
- Propulsion - 372cc two stroke
- 20 gallon fuel tank
- Empty airframe weight - 150 lbs.
- Gross take off weight - 300 lbs.
- Payload capacity – 50 lbs.
- One hard-point location per wing for launcher attachment



Made from 1" thick Aluminum
Tolerance +/- 0.05"

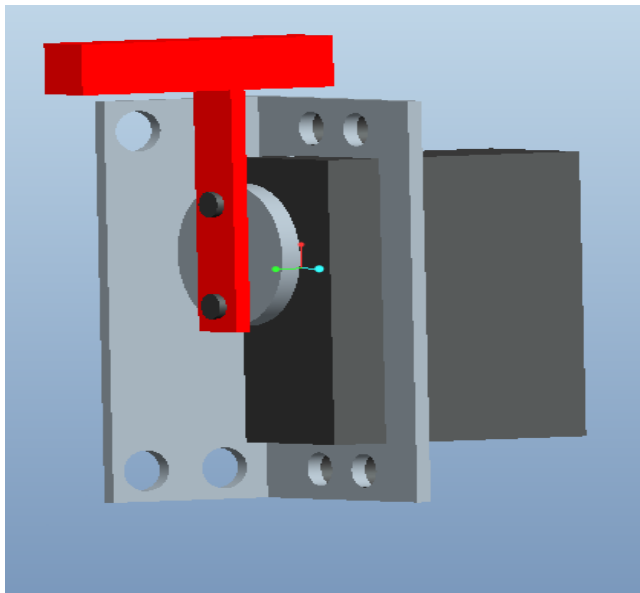
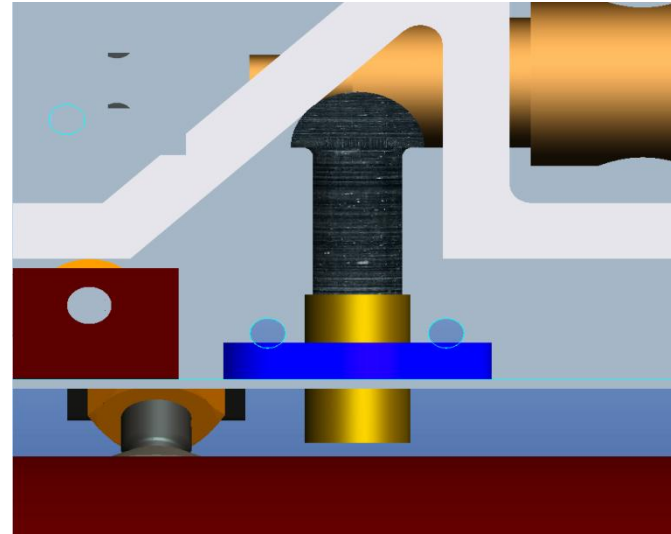
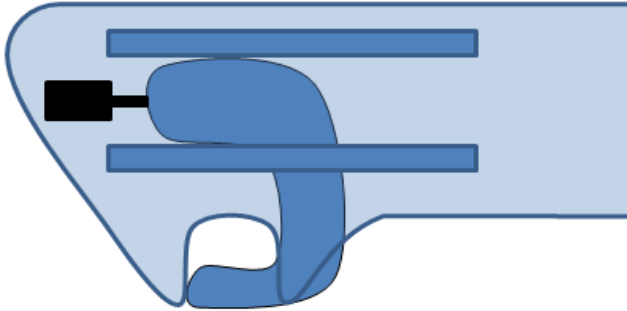
Constraints

- BRU must not exceed 5 lbs.
- Capable of holding a payload that is 10lbs
- Operation in temperature range -20 to 60 degrees C and during rain exposure
- Retain payload during aircraft maneuvers up to 2GS lateral load and 1G landing shock.

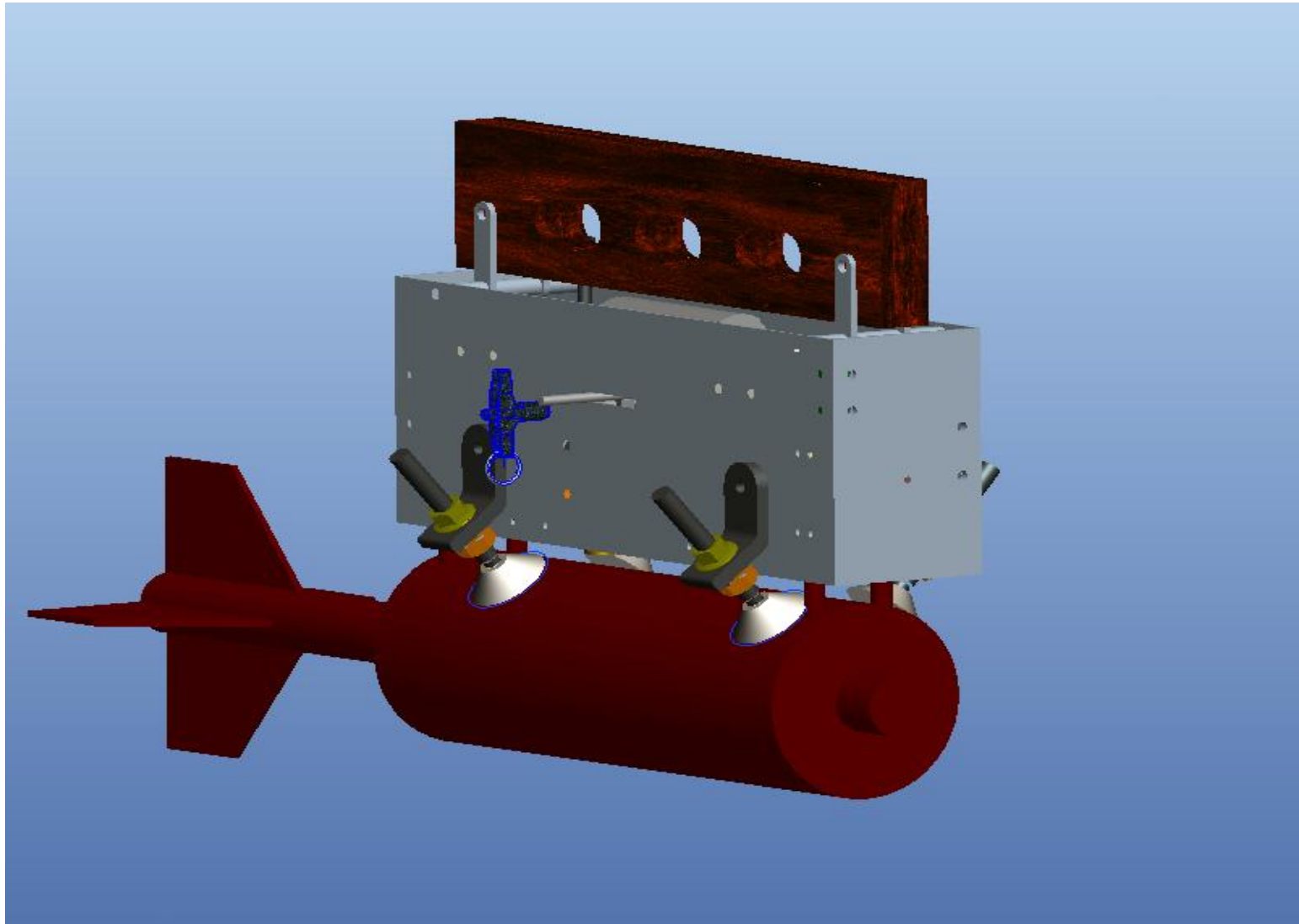


Weight = 10lbs
Tolerance +/- 0.125"

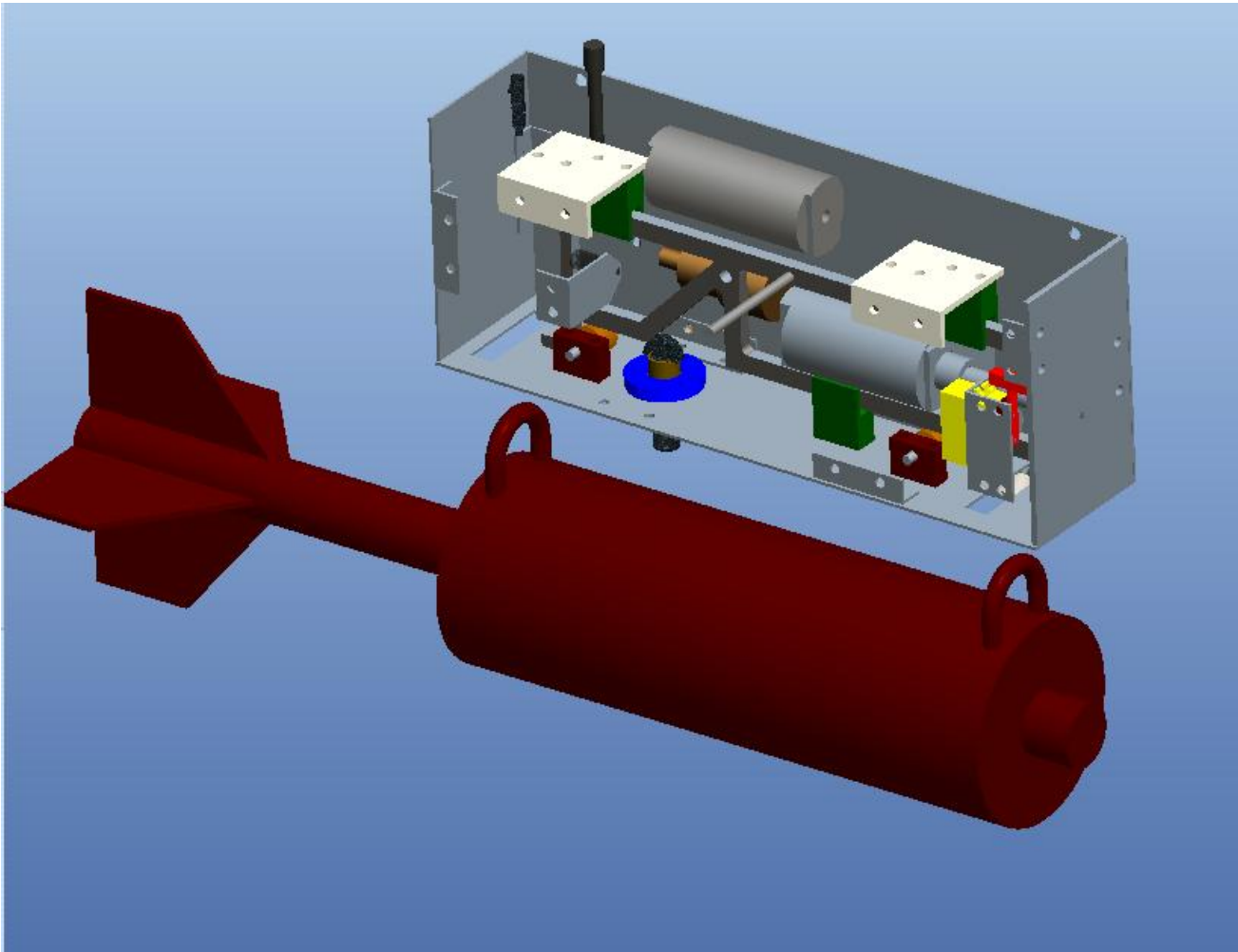
Concept Generation



Final Design

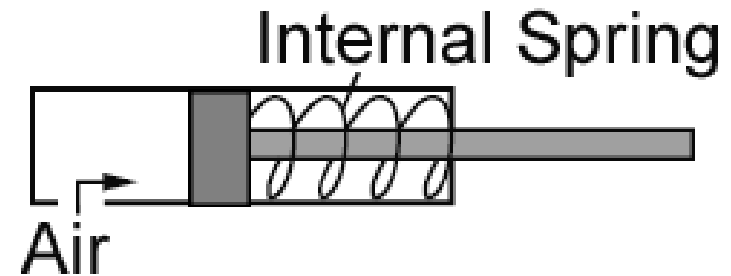


Final Design



Pneumatic System

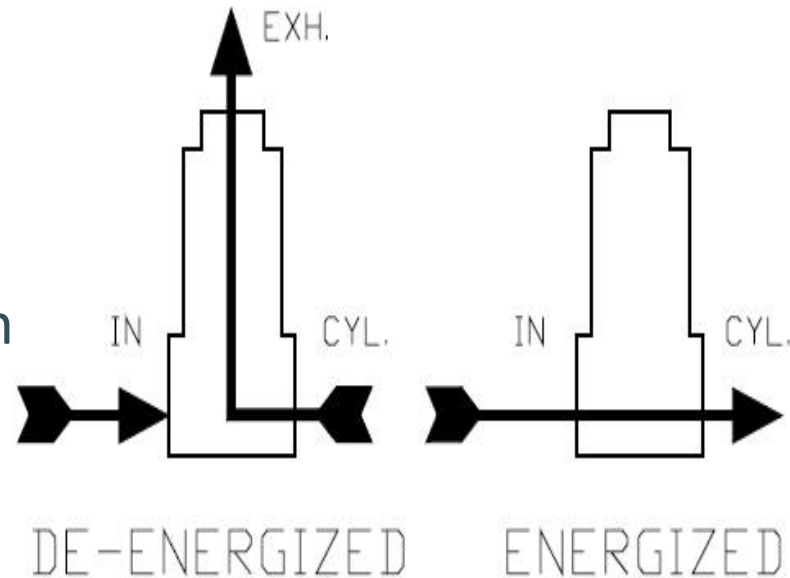
- Air Cylinder
 - Provides Linear Force to Open Hook
 - Single-Acting
 - 1 ½ inch Bore
 - 1 inch Stroke



mcmaster.com

Pneumatic System

- Solenoid Valve
 - Sends Air from Air Tank to Cylinder when Energized
 - De-Energizing Exhausts Air from Cylinder
 - Controlled by MicroDragon
 - Operates at 12VDC



cylval.thomasnet-navigator.com

Pneumatic System

- Air Tank
 - Holds Air Needed for Cylinder Operation
 - 4 cubic in
- Adjustable Relief Valve
 - Regulates Air Pressure
 - 90 psi
- Check Valve
 - Prevents Back Flow
 - Push-to-Connect Feature for Quick Re-Filling



clippard.com

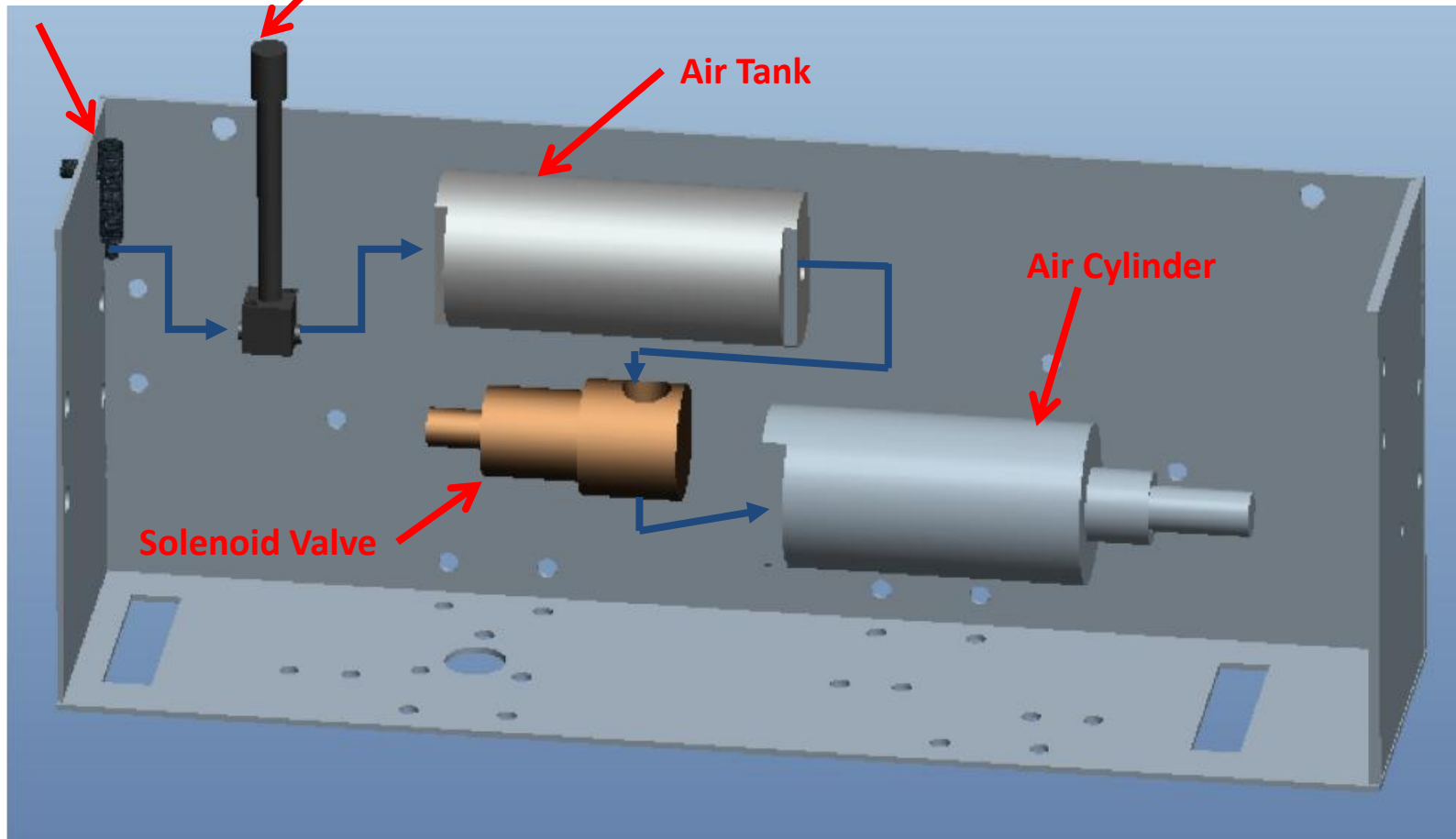


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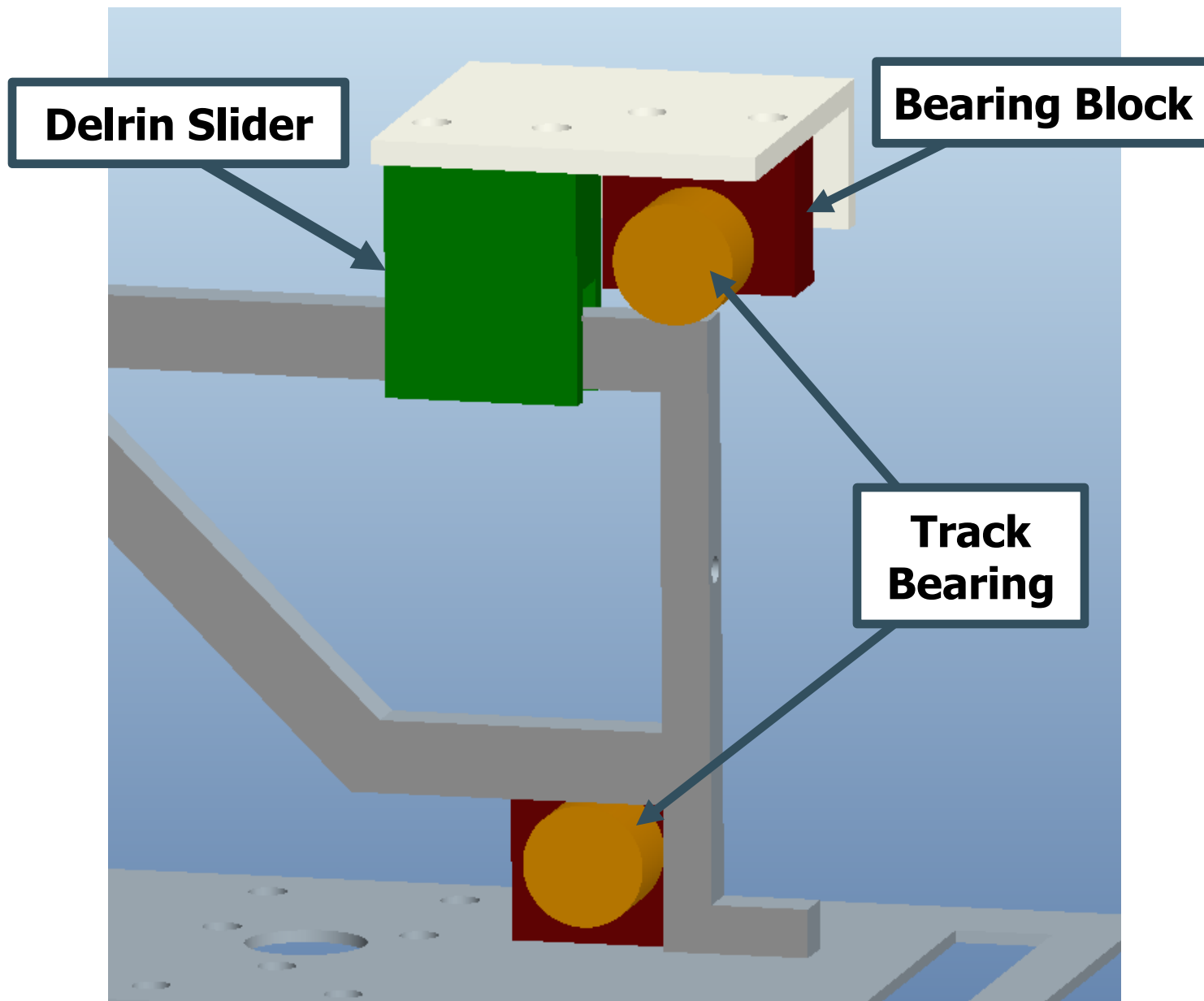
Pneumatic System

Check Valve

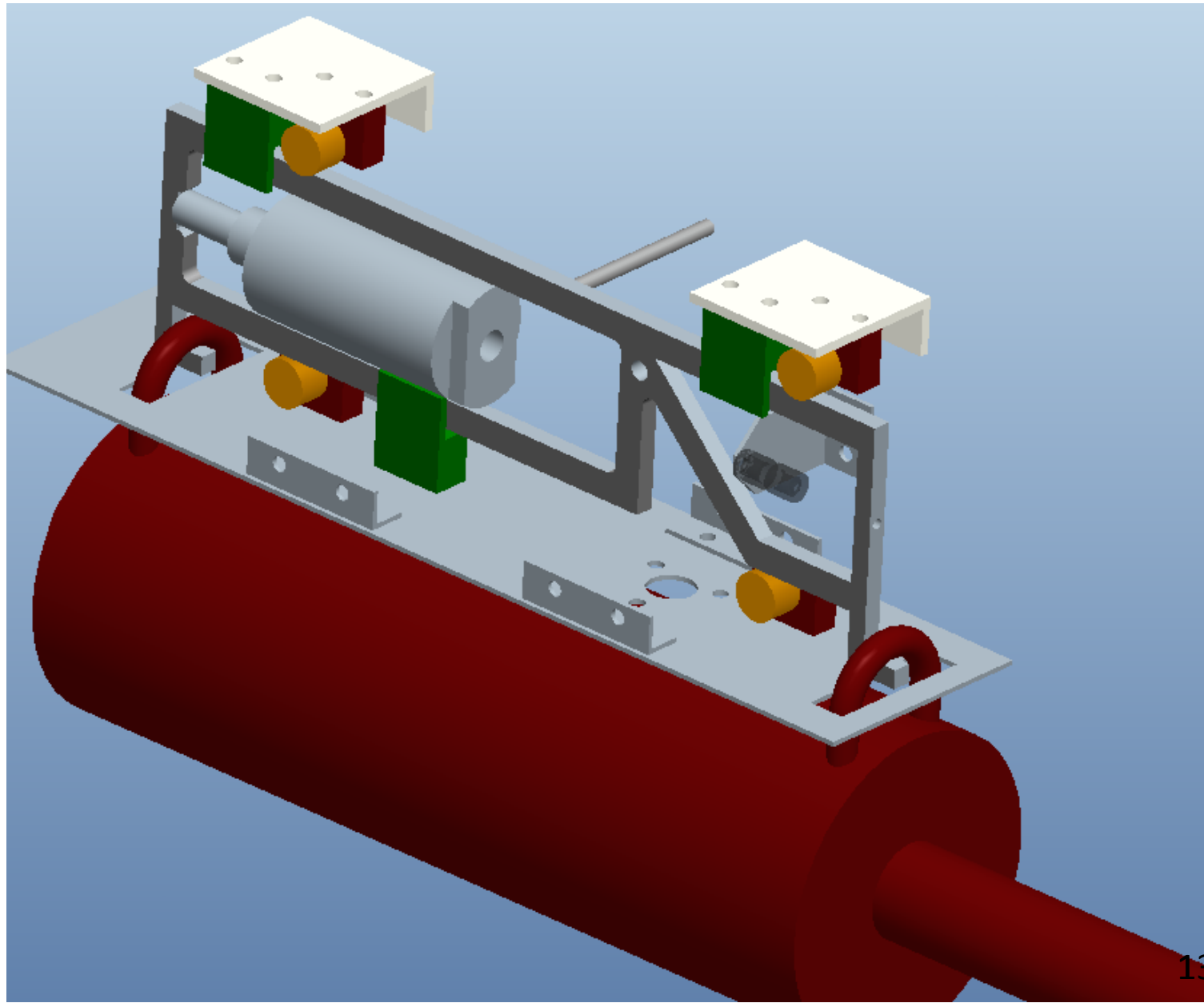
Regulator



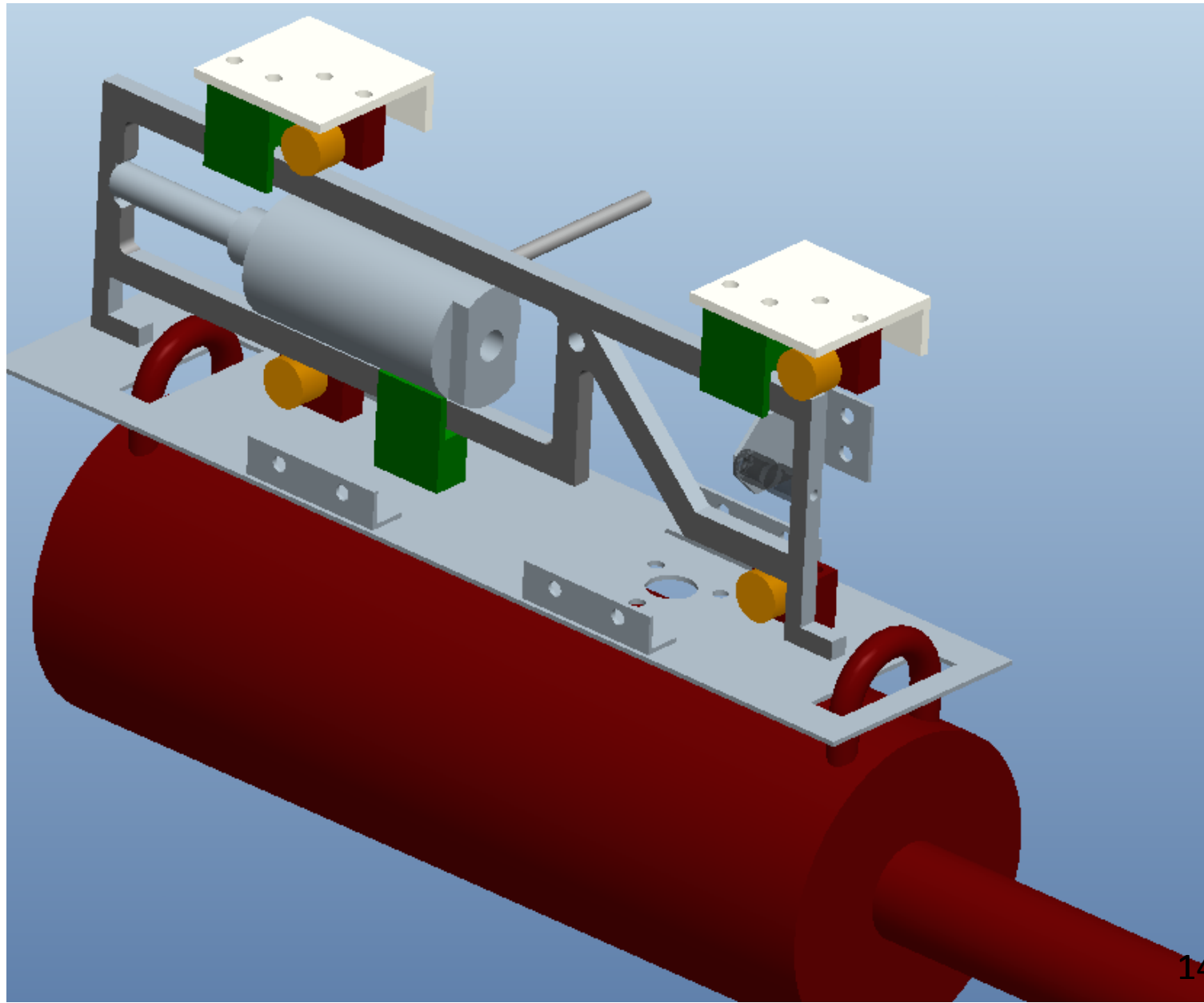
Bearing System



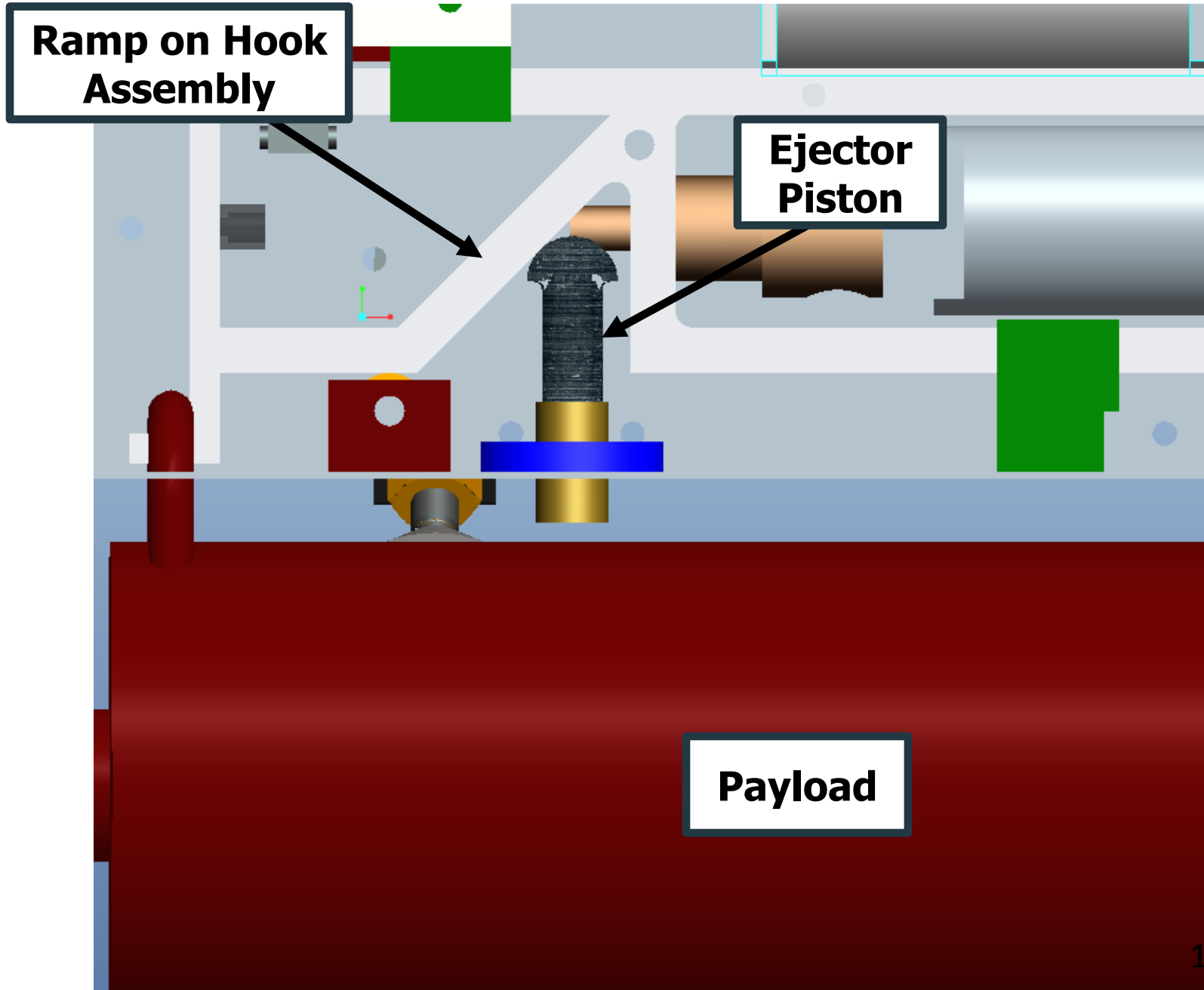
Hook Release (Closed)



Hook Release (Open)

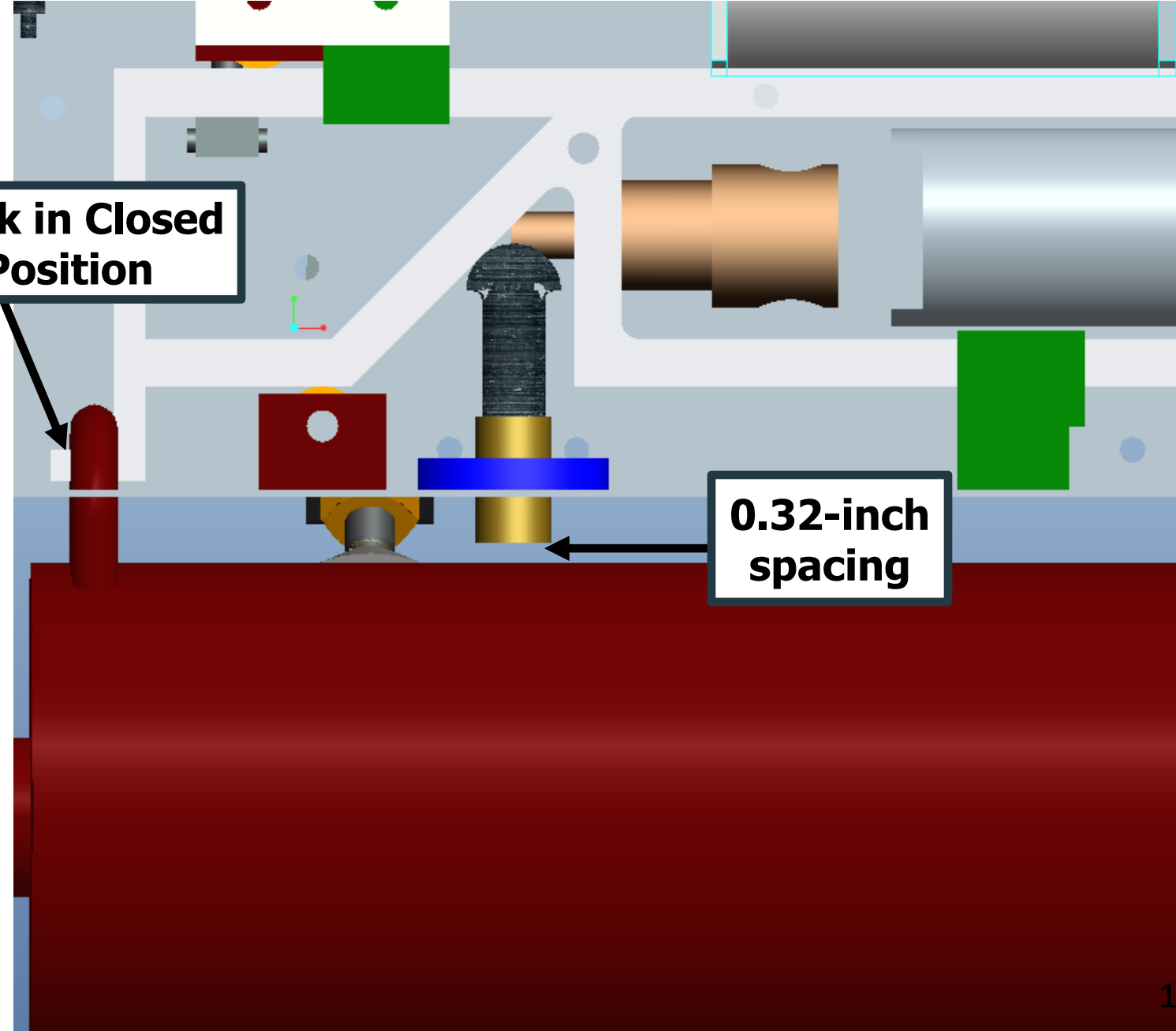


Ejector System



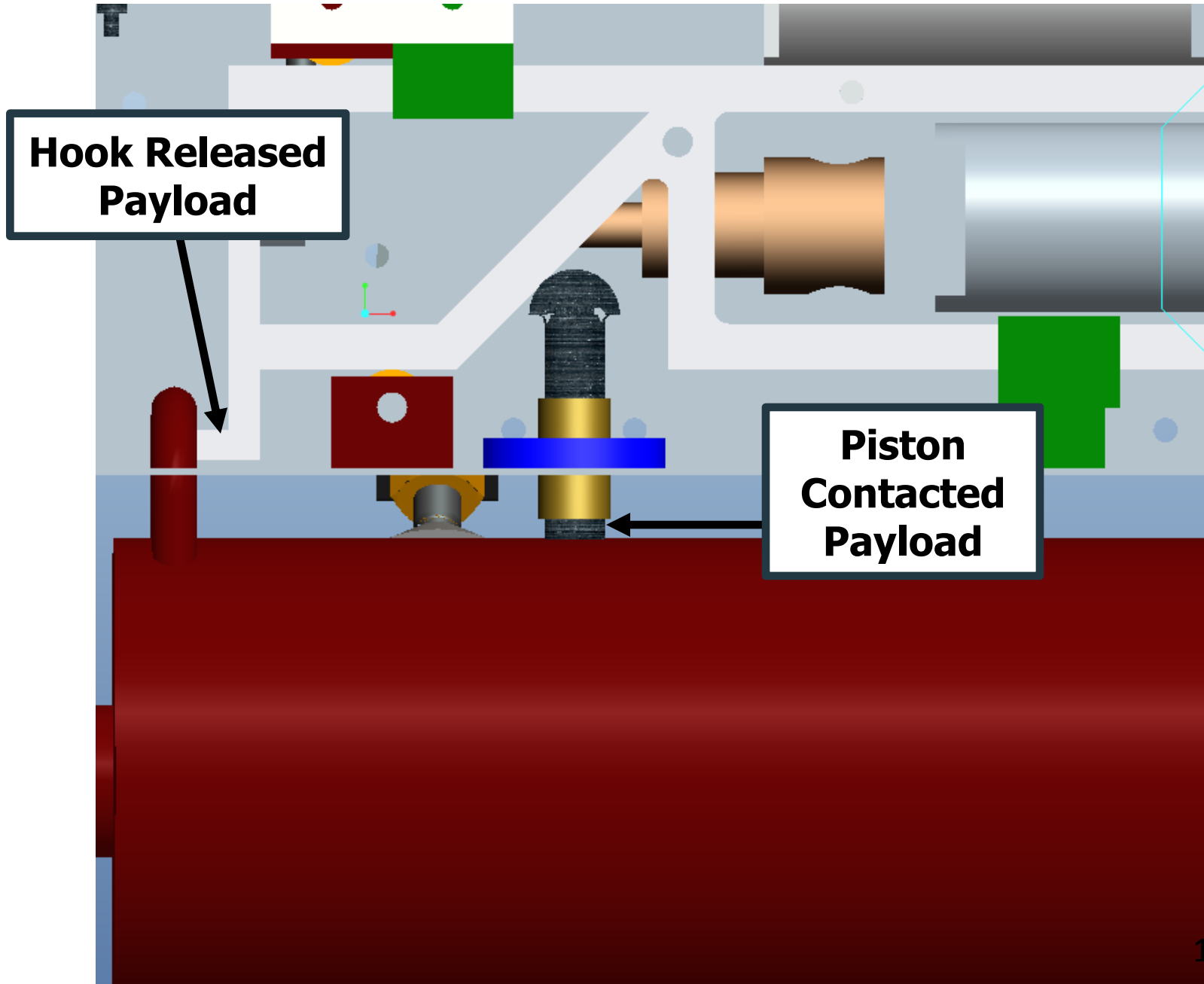
Ejector System

Hook in Closed Position



0.32-inch spacing

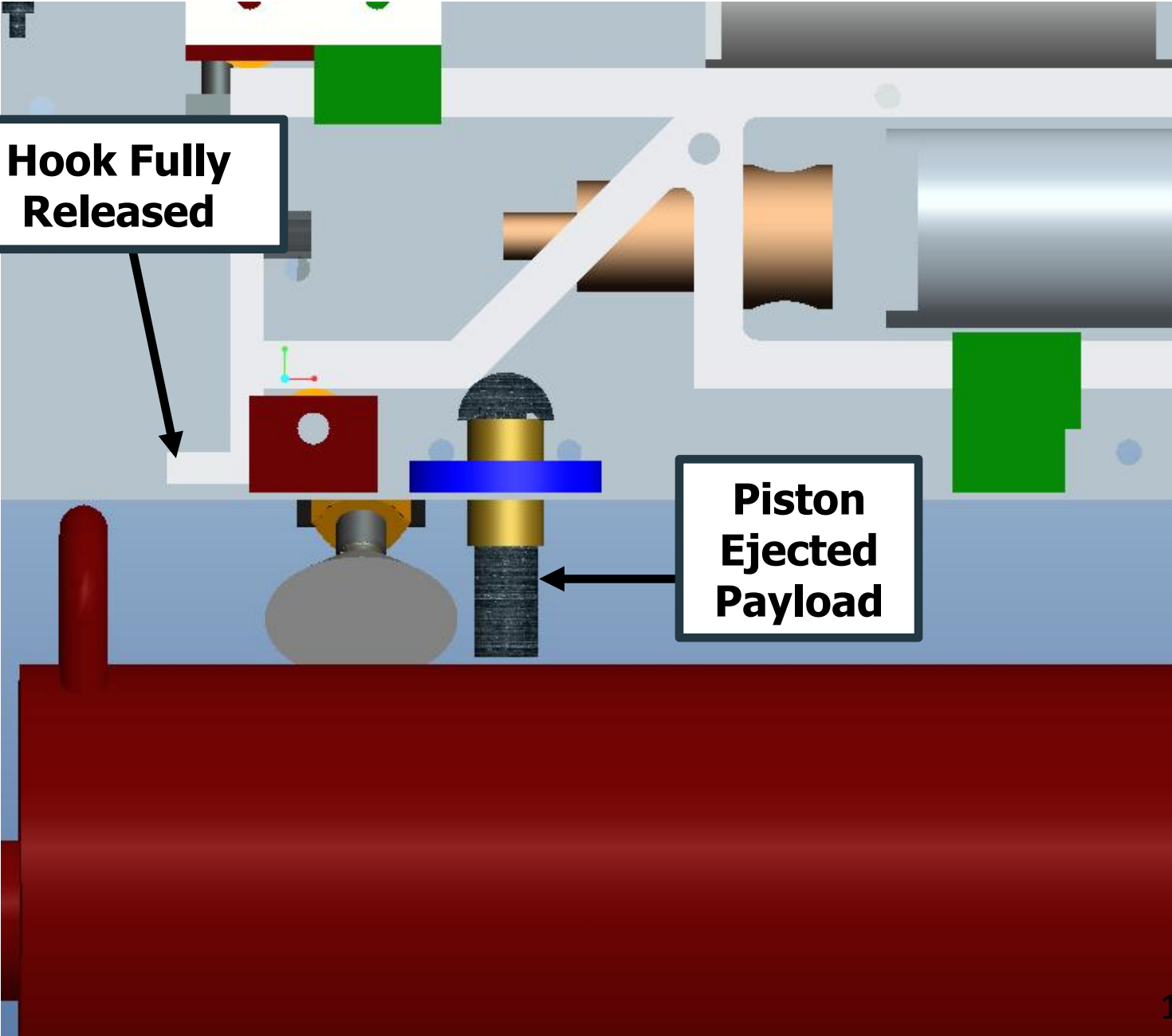
Ejector System



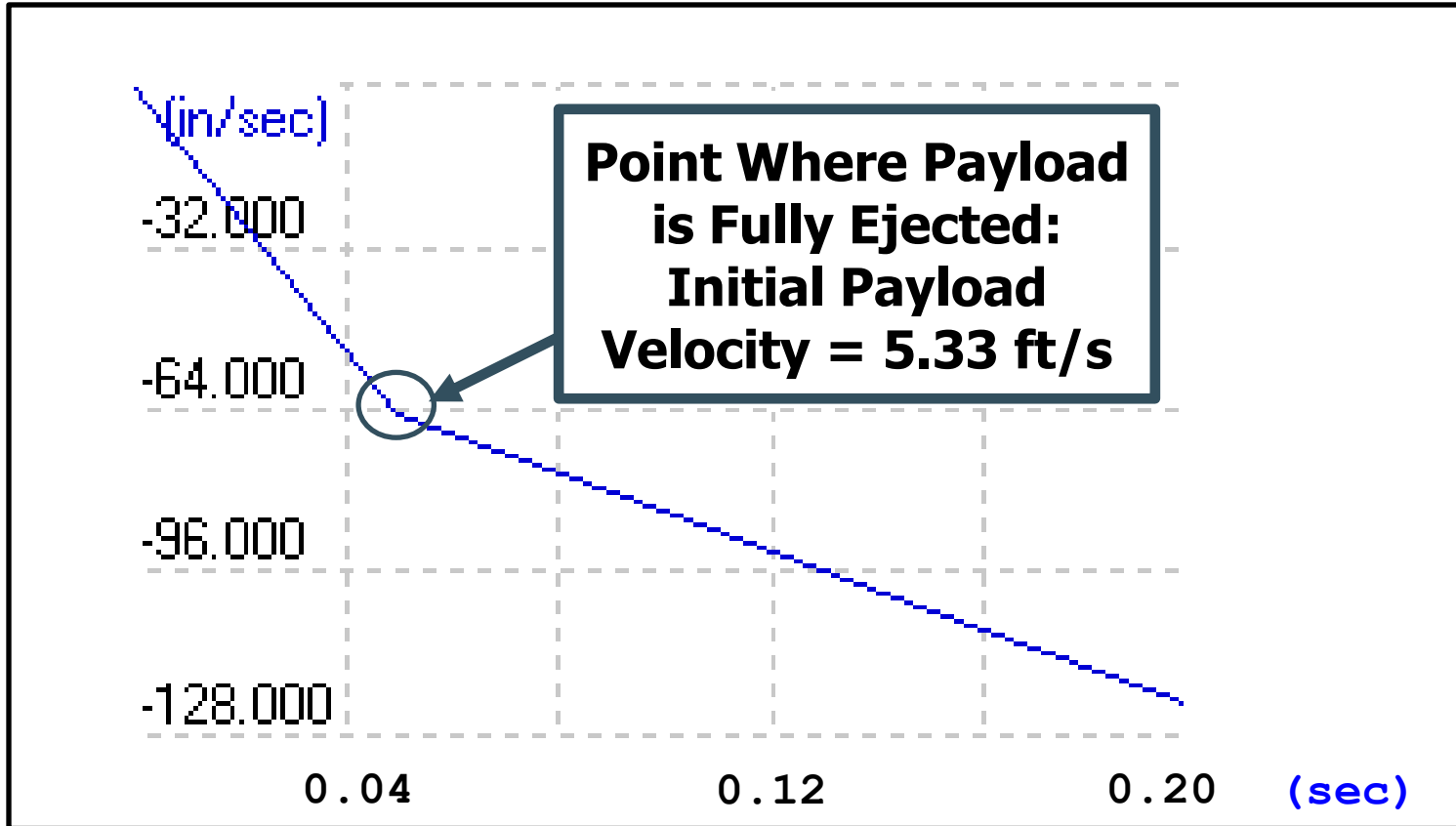
Ejector System

Hook Fully Released

Piston Ejected Payload

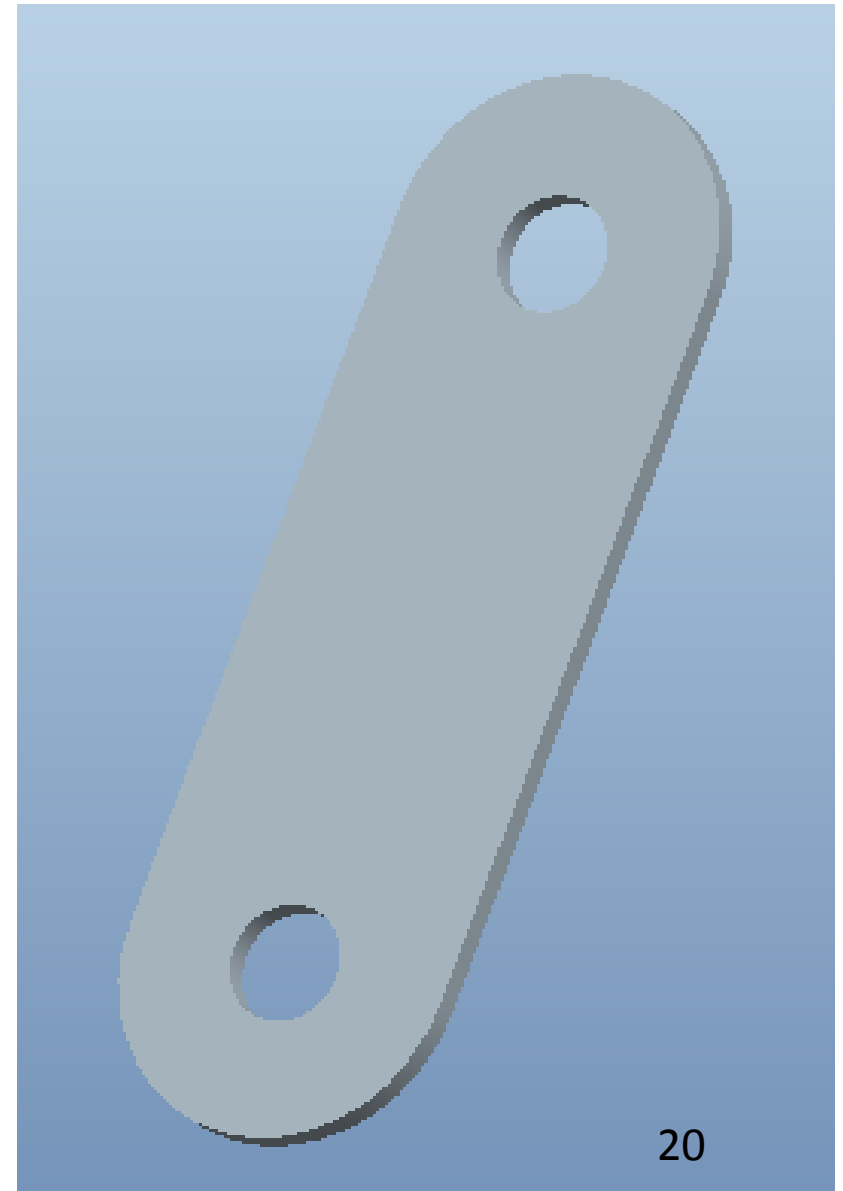


Ejector Mechanism Simulation



Mounting Tab

- Attaches BRU to pylon
- Supports weight of BRU and payload during combined loading situations of up to 2G lateral force and 1G landing shock
- Retains BRU assembly during aircraft maneuvers up to 2G lateral load and 1G landing shock.



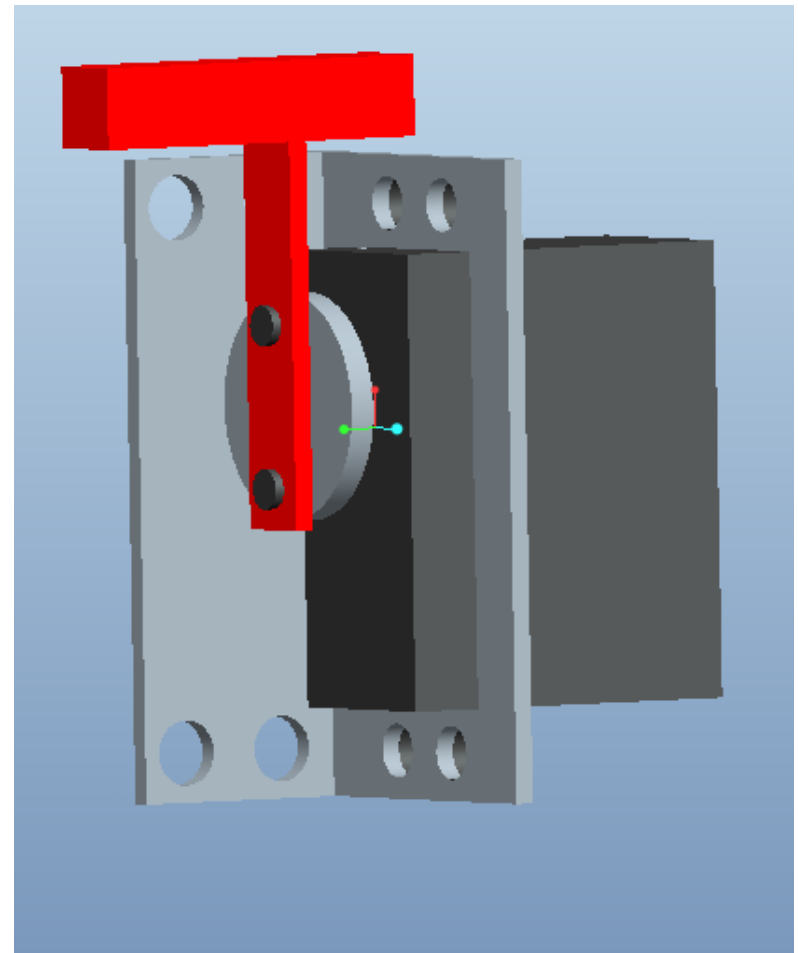
Mounting Tab Combined Loading

Type of Loading	Responsible Force/Moment	Equation Used
Normal Stress	F = Total system mass * 2G downward (includes 1G landing shock)	$\sigma_n := \frac{F}{A} = 426.667 \text{psi}$
Shear Stress	F = Total system mass*2G downward (includes 1G landing shock)	$\tau_{\text{shear}} := \frac{V \cdot Q}{I \cdot t} = 1.28 \text{ksi}$
Bending Stress	M = Total system mass * 2G lateral * lever arm from the system COG	$\sigma_b := \frac{M \cdot c}{I} = 35.43 \text{ksi}$
Bending Stress	M = Wind force @ 75mph * frontal area	$\sigma_w := \frac{M \cdot c}{I} = 0.779 \text{psi}$
Total Stress = 37.14 ksi		

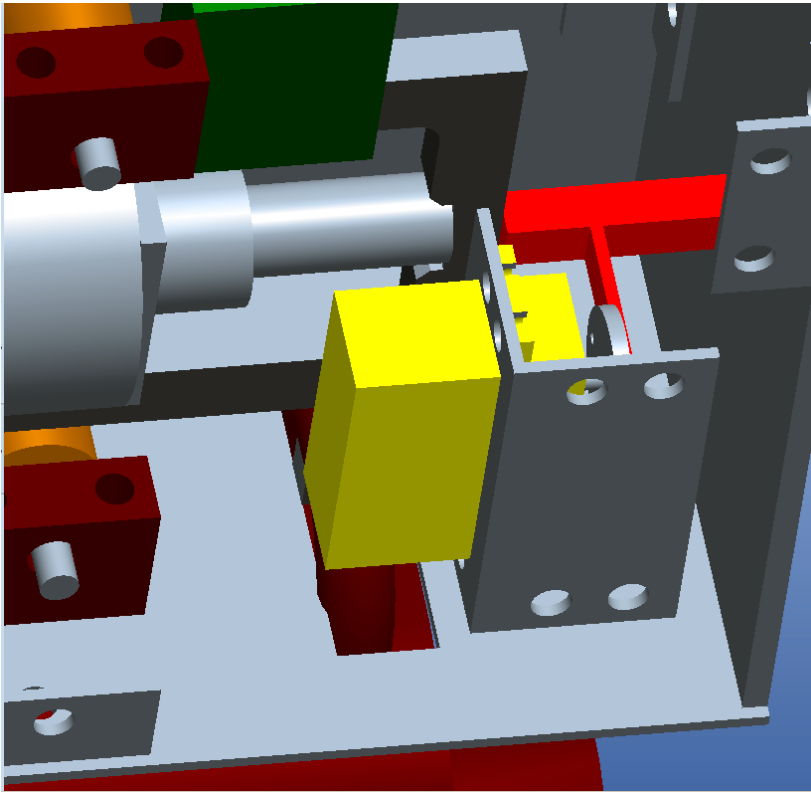
- Tab optimized to a thickness of 1/8-inch
- Total stress = 37.14 ksi / 4 tabs = 9.29 ksi per tab
- AL6061 Ultimate Tensile Strength = 17 ksi
- $FOS = \sigma_{\text{ult}} / \sigma_{\text{perTab}} = 1.828$

Safety System

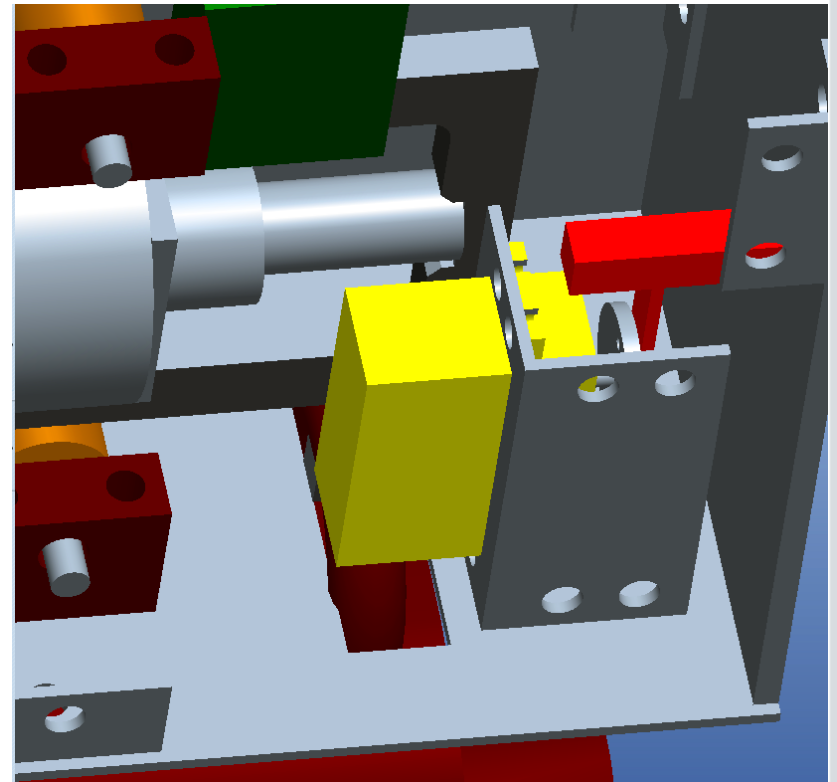
- Output $\tau = 4.75$ lb-in
- Required $\tau = 0.0066$ lb-in
- Block made of Al6061
- Servo weighs 15/16 oz
- Requires 4.8V input



Safety System



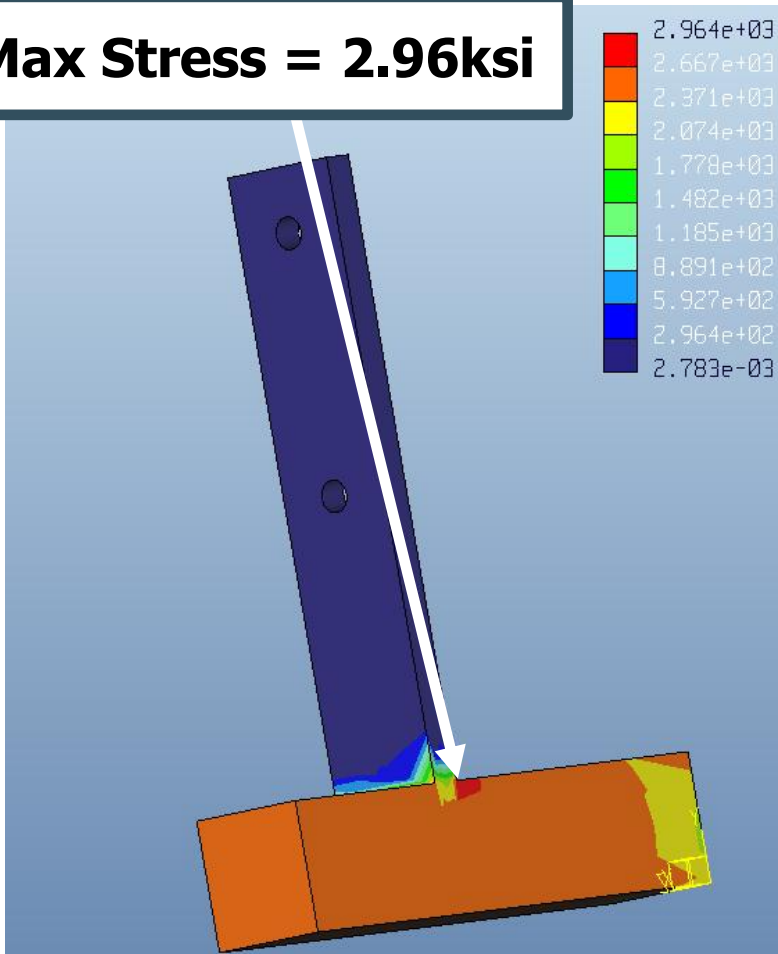
Closed Position



Open Position

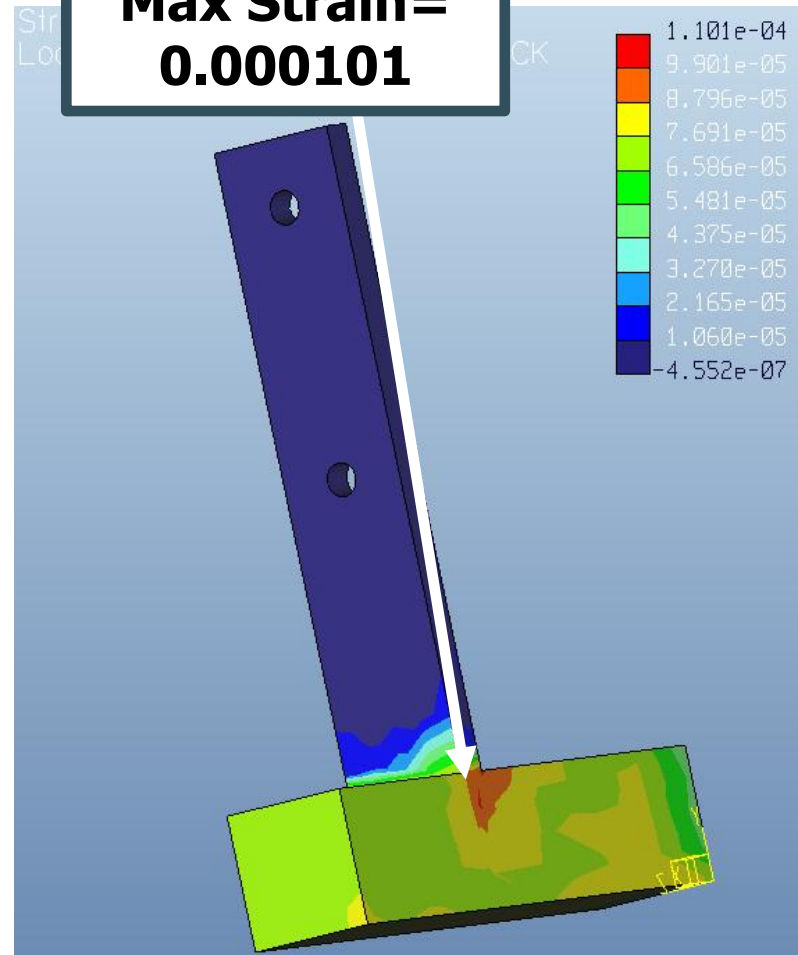
Safety System

Max Stress = 2.96ksi



Von Mises Stress

Max Strain = 0.000101

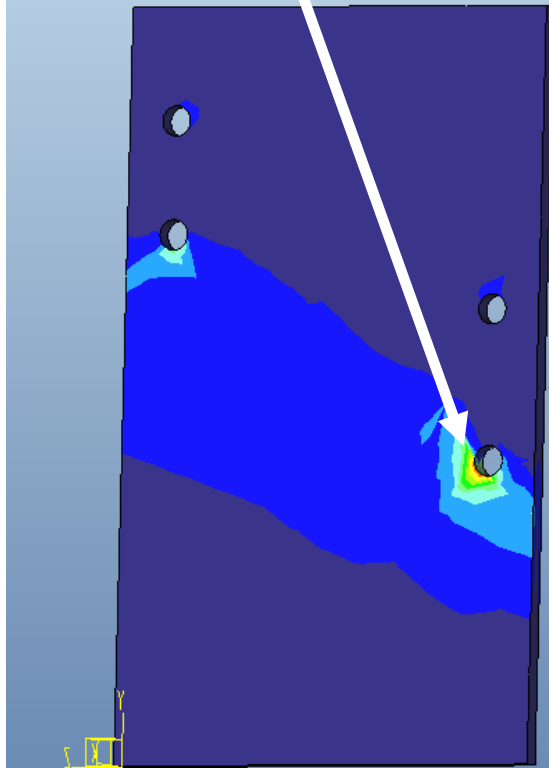
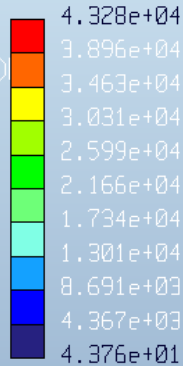


Strain

Safety System

Stress von Mises (WCS)

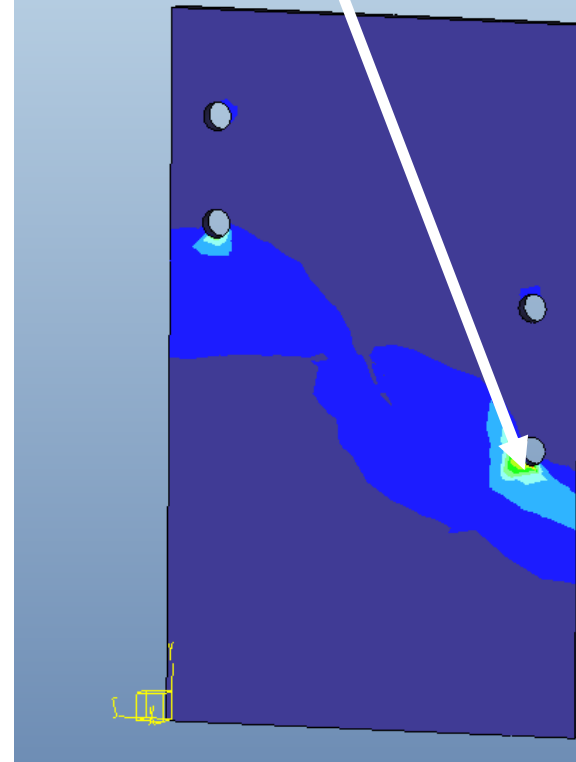
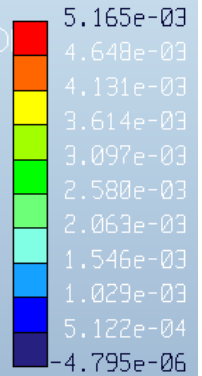
Max Stress = 43.3 ksi



Von Mises Stress

Strain

Max Strain = 0.005165



Strain

Sway Brace

- Withstand lateral and vertical loads
- Bracket machined AL6061
- Safety Factor of 1.5

- $\sigma = \frac{F}{A}$

- $\tau = \frac{F}{A}$ h

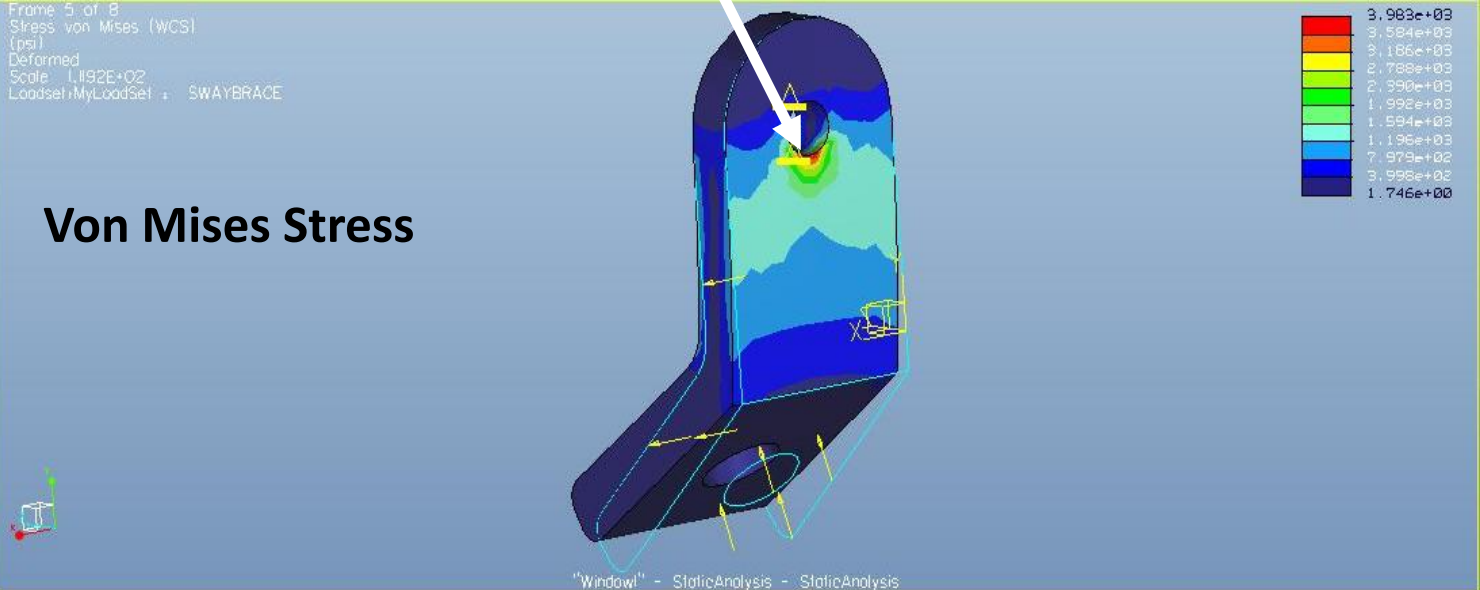
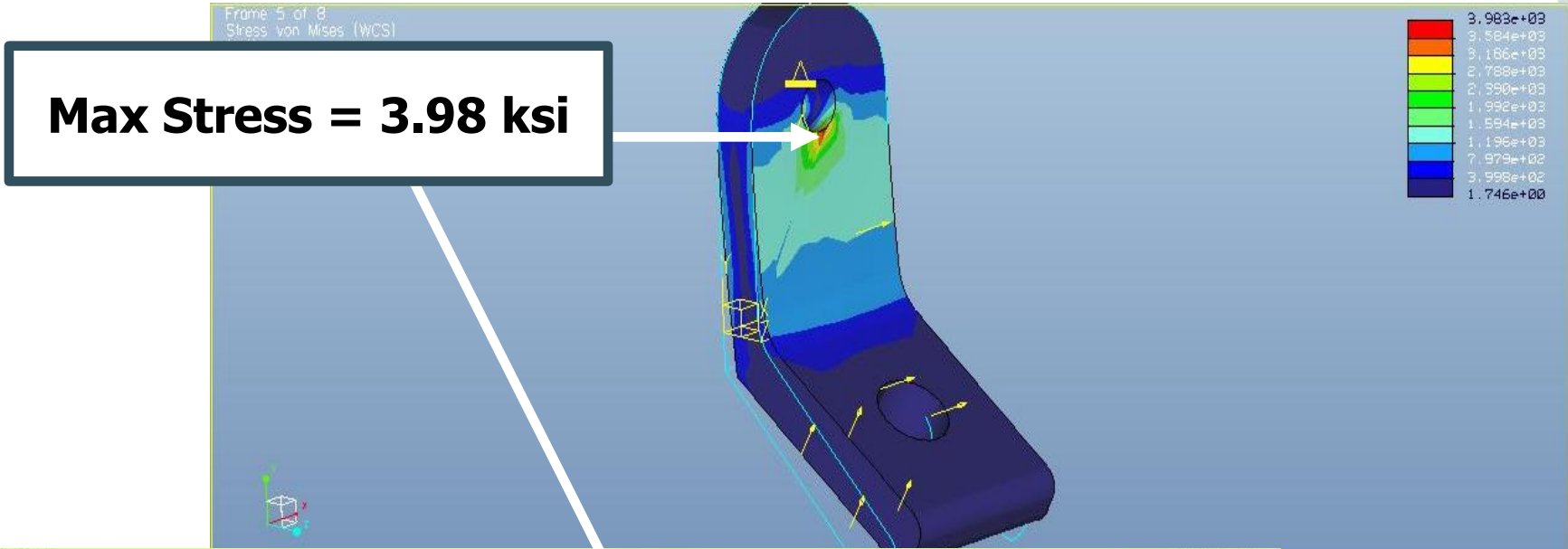
- $\sigma = \frac{F}{A}$ $\sigma =$

- $\sigma = \frac{F}{A}$ $.00256 * \sigma^2$

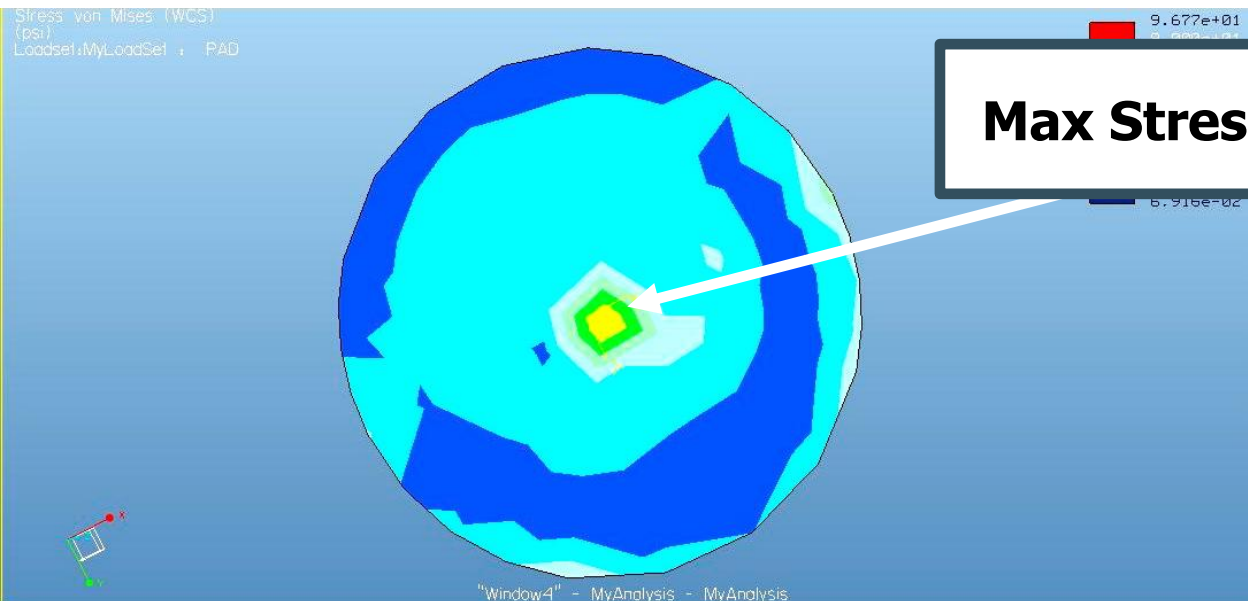
- $\sigma = \frac{F}{A}$ ≈ 2.0



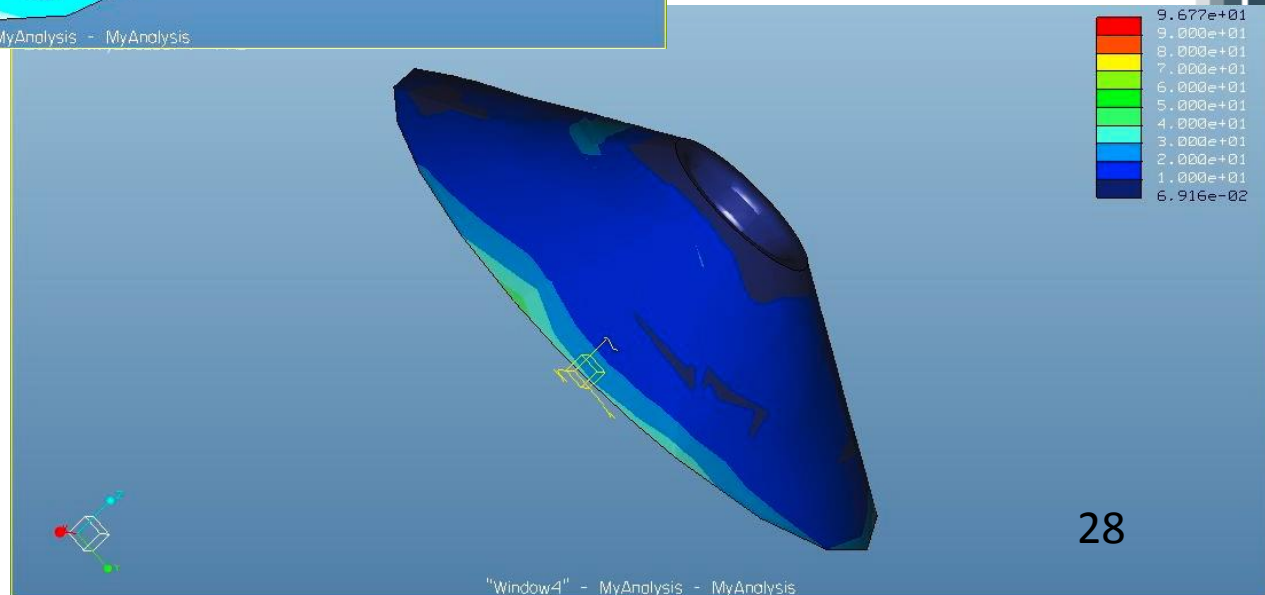
Sway Brace (Bracket)



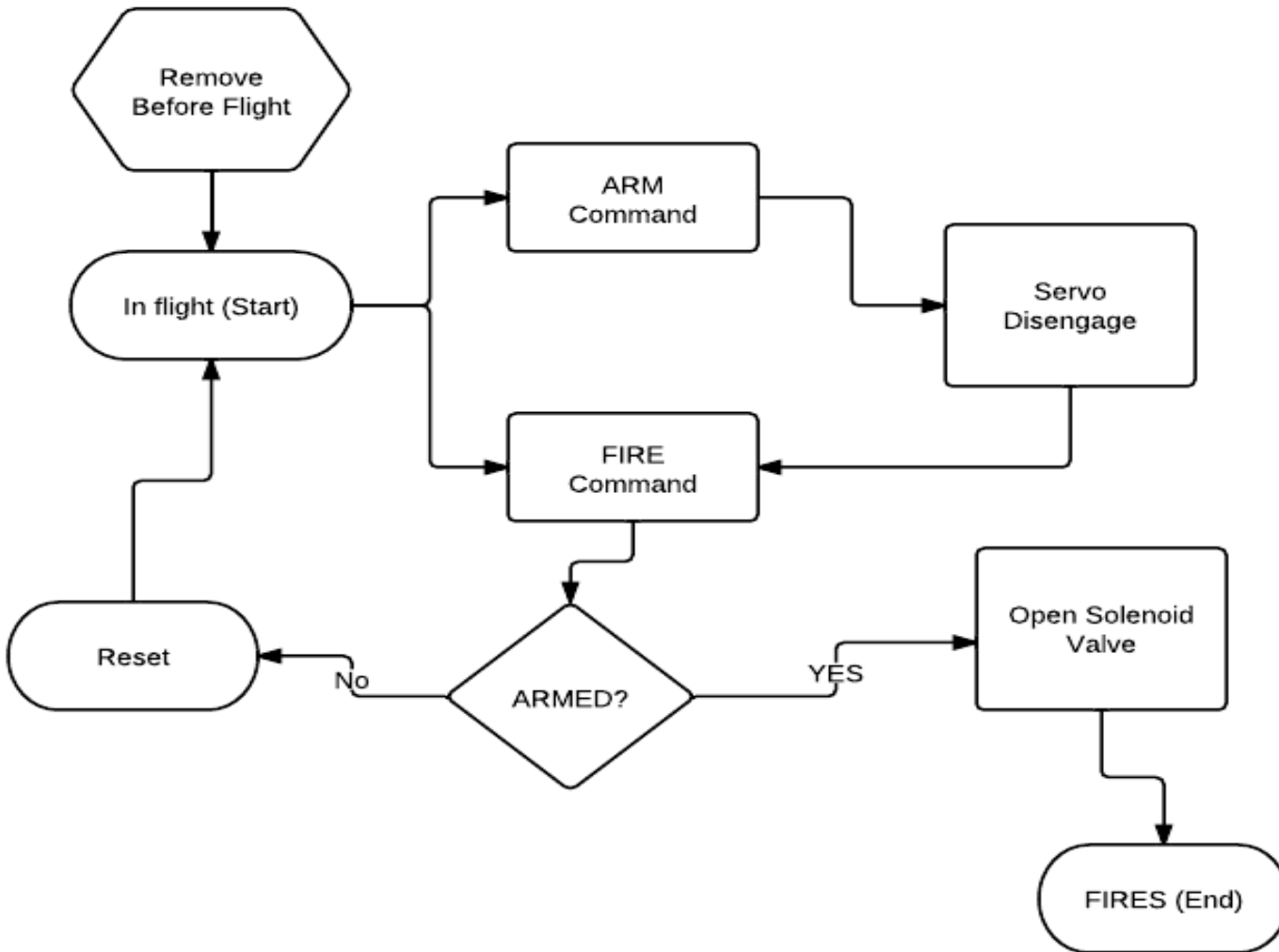
Sway Brace (Pad)



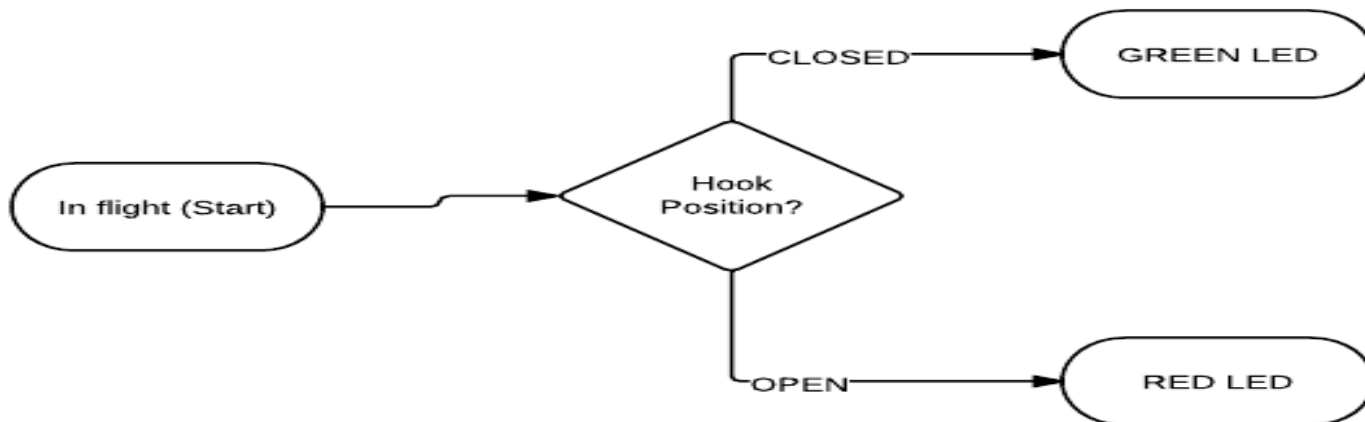
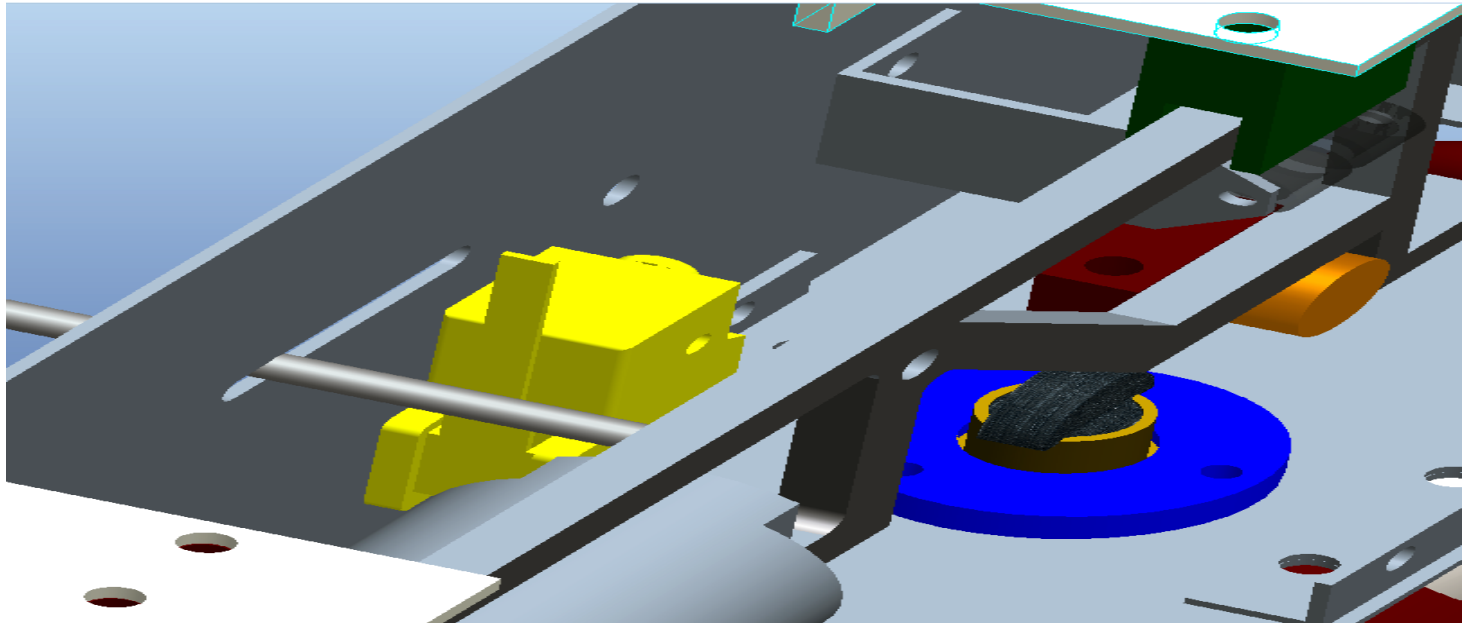
Von Mises Stress



Electrical Interface

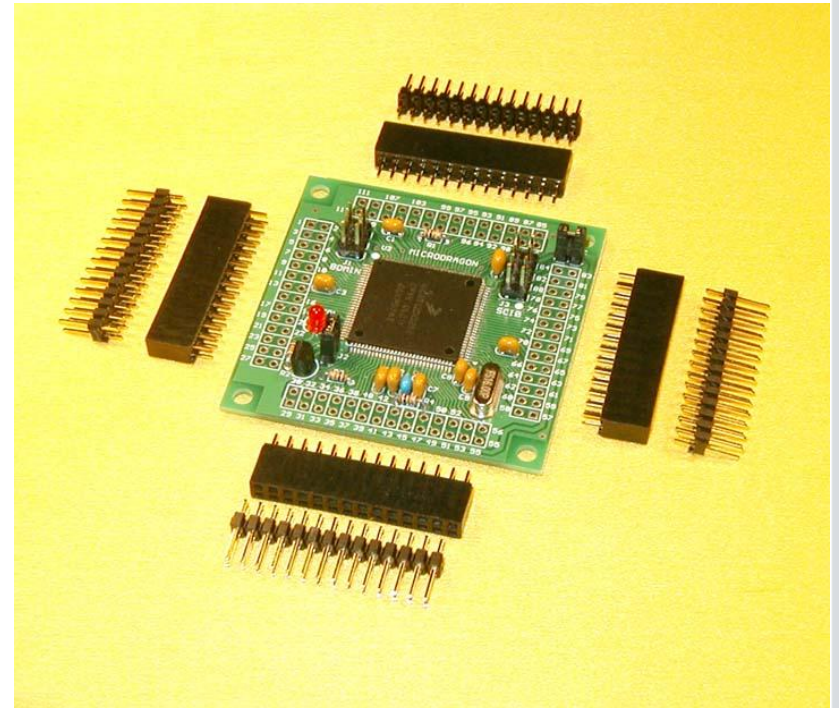


Electrical Interface



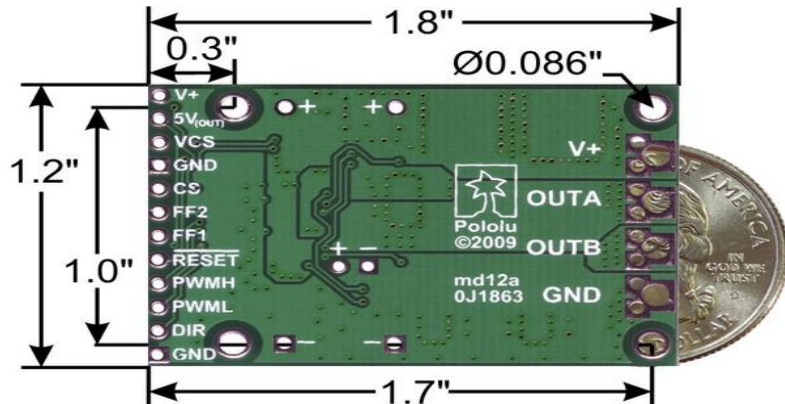
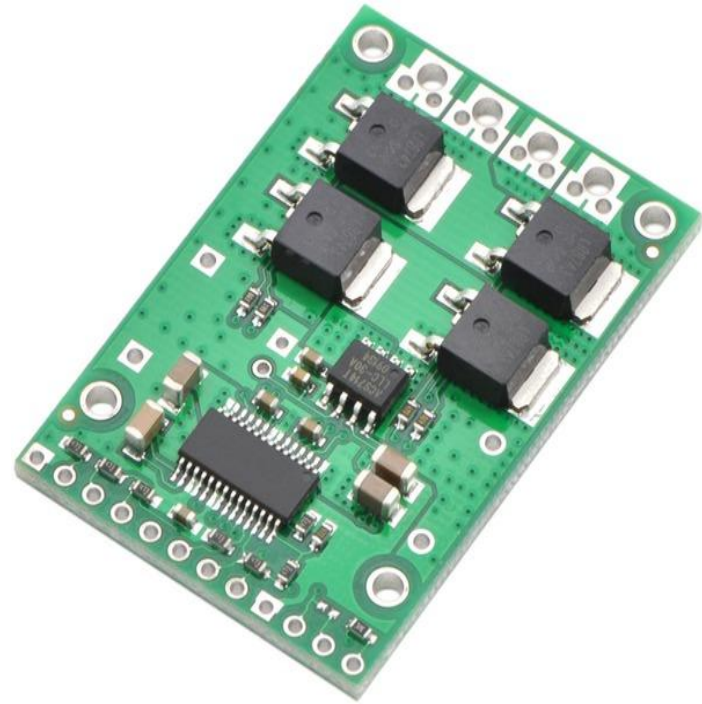
MicroDragon

- 8 MHz – 25MHz default bus speed
- Pre-installed with Serial Monitor for CodeWarrior
- Small PC board size 2.2" X 2.2"
- It can provide 5V for a target board
- Can be powered by an external regulated 5V



Motor Driver

- 5.5 to 30 Voltage range
- Continuous 25A without a heat sink
- With heat sink can output 40A
- Includes a current sensing circuit
- Outputs an analog voltage proportional to the motor current



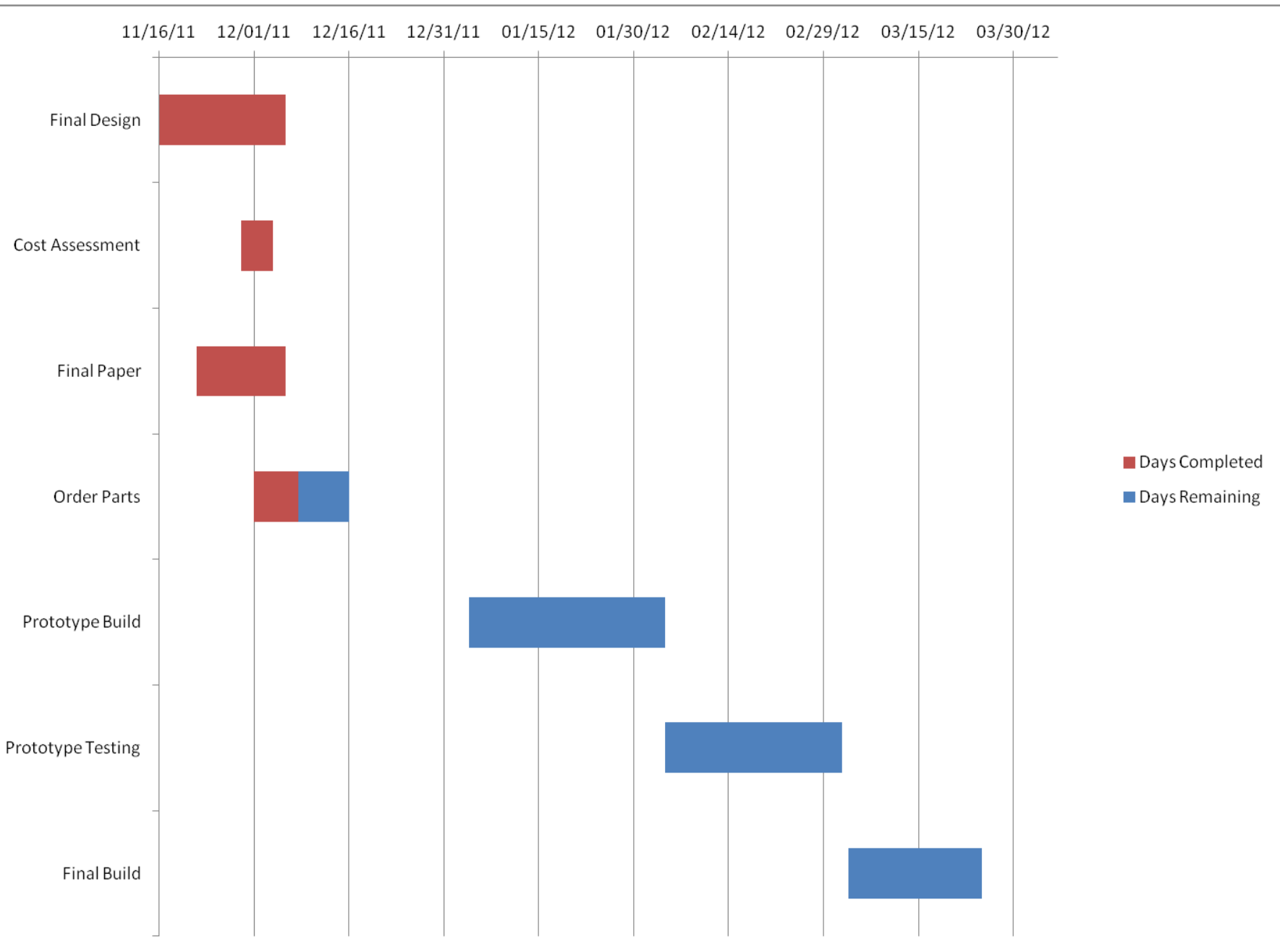
<http://www.pololu.com/catalog/product/1455>

Cost Analysis

<u>Purchase Items</u>					
Part	Vender	Part Number	Price	Quantity	Total Price
Air Cylinder	McMaster	6498K211	\$33.42	1	\$33.42
Air Tank	Clippard	AVT-24-4	\$16.82	1	\$16.82
Check Valve	McMaster	3208K22	\$14.74	1	\$14.74
Regulator	McMaster	99045K48	\$34.80	1	\$34.80
Solenoid	cylval	SA31NC	\$43.80	1	\$43.80
Guide_roller	Grainger	1ZGT7	\$48.25	4	\$193.00
Ejector_bushing	McMaster	6377K114	\$20.27	2	\$40.54
Ejector_spring	Grainger	1NCT2	\$7.69	1	\$7.69
MicroDragon	EVBplus		\$55	1	\$55.00
Motor Driver	Pololu	1455	\$59.95	1	\$59.95
UTB cord	EVBplus		\$14.00	1	\$14.00
Pushspring	McMaster	9657K48	\$6.29	1	\$6.29
Servo	Futaba	FUTM0513		1	\$0.00
Limit Switch	McMaster	7090K37	\$7.91	1	\$7.91
RBF PIN	McMaster	90293A139	\$17.98	1	\$17.98
Raw Material	Various				\$125.97
Total					\$671.91

Weight Analysis

<u>Material Weight</u>	
Assembly	Total
Hook Eject	1.0191
Mech Safety	0.0944
Ejector	0.1606
Pylon Attach	0.0574
BRU Casing	0.9515
Push Spring	0.0156
Pneumatic System	0.4213
Sway Brace	0.8803
Other	1.2808
Total	4.881



Questions ????



References

- Callister, William D. *Materials Science and Engineering*. 7th ed. New York: Wiley., 2006. Print.
- Hibbeler, R. C. *Engineering Mechanics Dynamics*. 12th ed. Singapore: Pearson/Prentice-Hall, 2009. Print.
- Hibbeler, R. C. *Engineering Mechanics: Statics*. Upper Saddle River, NJ: Prentice Hall, 2009. Print.
- Hawks, Chuck. ".22 Rimfire Cartridges." *CHUCKHAWKS.COM: Guns and Shooting Online; Motorcycles and Riding; Military History; Astronomy and Photography Online; Travel and Fishing Information Guide*. Web. 18 Oct. 2011. <http://www.chuckhawks.com/22_rimfire_cartridges.htm>.
- "HowStuffWorks "Airbag Inflation"" *HowStuffWorks "Auto"* Web. 13 Oct. 2011. <<http://auto.howstuffworks.com/car-driving-safety/safety-regulatory-devices/airbag1.htm>>.