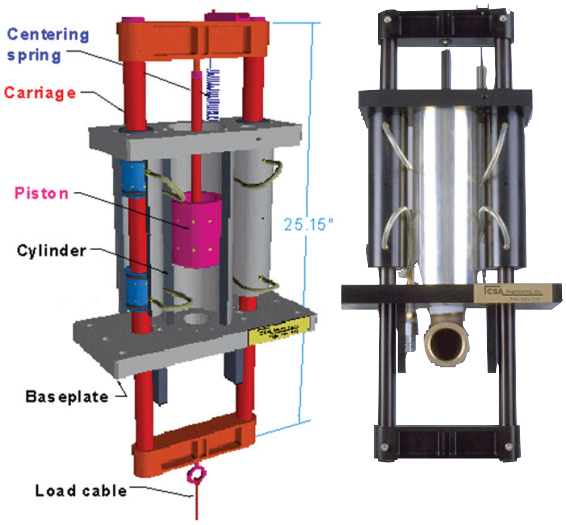
Zero Gravity Simulation

Wide payload range. Suspension Frequency <0.2 Hz. Zero static deflection. Zero friction.



Standard Model AGM-350-6

CSA's line of zero-gravity simulation devices deliver highly accurate free-free boundary conditions for your sensitive payloads.

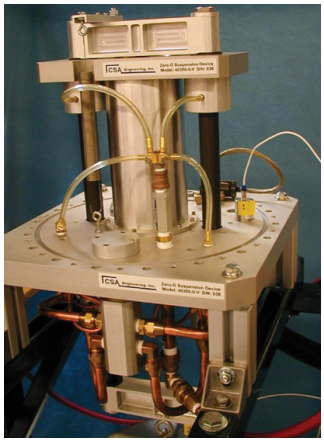
The semi-passive air spring suspension system offers a wide payload range, very low stiffness, zero static deflection, and zero friction. It outperforms conventional technologies which suffer from suspension stiffness, added mass, friction, or vibration modes of the suspension devices, themselves.

Our devices are also highly customizable: the pneumatic suspension system can be combined with electromagnetic actuation to deliver high precision positioning in addition to targeted vibration isolation. In this form they are readily integratable into 6-DOF motion simulators, or vibration suppression applications requiring precise position trim control.

Deployable structures can be gravity offloaded with the "walking" version of our zero-g suspension devices. This fully integrated solution utilizes closed loop horizontal payload tracking ability to follow a payload translating in all three directions.

See our custom applications section to find out what CSA's zero-g simulation technology can do for your next application.

Custom Applications

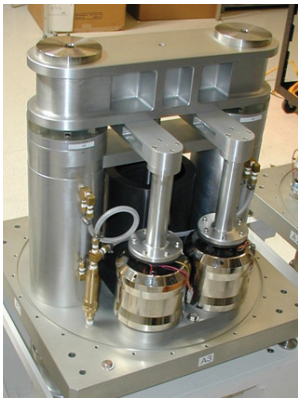


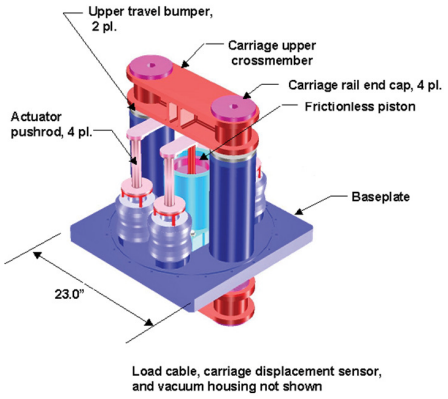
Vacuum Compatible

- Custom air bearing design with active scavenging minimizes air leakage.
- 3-device system delivered to NASA / Goddard Space Flight Center.

Large Payloads

- Single device supports 2400 lb payload from below while accommodating a 10 inch range of motion.
- 3-device system delivered to Air Force Research Laboratory for SPICE testbed.





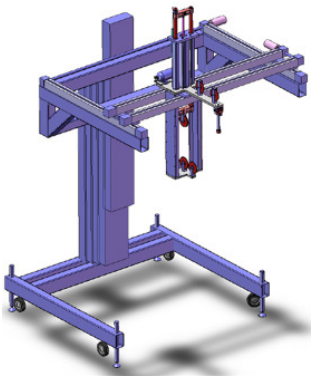
Pneumatic/Electromagnetic System

- "Passive" pneumatic system supports nominal payload weight. Active electromagnetic system corrects for small, slow, random variations in piston pressure
- 14-device system delivered to Lockheed Martin to support 35,000-lb payload in vacuum with very high ride-height stability

CSA Engineering, A Moog Company
2565 Leghorn St. ▪ Mountain View, CA 94043-1613 ▪ 650.210.9000 ▪ 650.210.9001 fax
www.csaengineering.com ▪ info@csaengineering.com

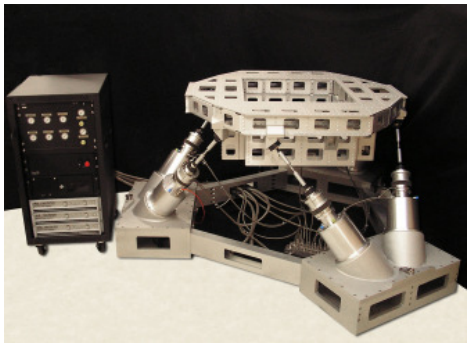
Downward Loading

- A major tire manufacturer uses two devices to apply downward force during tire testing. Devices add minimal amount of mass or stiffness to unit under test.



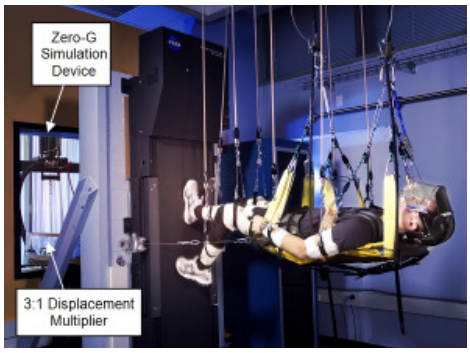
Horizontal Tracking Capability

- Fully integrated system combines zero-g simulation technology and closed loop payload tracking to gravity offload a payload translating in all three directions.
- System can accommodate up to 6 feet of travel in all three directions, which is ideal for ground-based testing of deployable space structures such as magnetometer booms, solar arrays, and robotic ion thruster arms.



Combined Motion Simulation and Vibration Isolation

- 6-DOF, vacuum compatible, motion simulator leverages hybrid pneumatic/electromagnetic actuation to deliver controlled motion and optimal vibration isolation to spacecraft or other payloads.
- Strut geometry is re-configurable to yield best combination of payload-specific vibration isolation and motion simulation.
- Ideal for precision beam pointing applications which require closed loop position control and high degree of vibration isolation.



Human Gravity Offloading

- The Cleveland Clinic uses a single device to study exercise countermeasures intended to maintain musculoskeletal health under zero-gravity conditions

Model	AGM	AGM-A	WAGM
Payload capacity, lbs	5-1500	10-1500	5-200
Typical vertical suspension frequency (Hz)	0.1-0.2	0.1-0.2	0.1-0.2
Device vertical stroke, in.	0.5 to 18	0.5 to 18	0.5 to 18
Total Range of motion (X Y Z, in)	N/A	N/A	78.6 x 51.0 x 69.0
Moving mass, lbm	6	"9 (w/o mass canceling) 1.4 (w/ mass canceling)"	1
Air spring stiffness, lbf/in	payload-dependent	payload-dependent	payload-dependent
Friction, % payload weight	< 0.005	< 0.005	0.1
Device outline (H x W x D, in)	27.8 x 12.0 x 5.5	28.6 x 12.5 x 7.5	72.4 x 14.0 x 32.75
Air consumption at max payload, SCFM	1.5	1.8	1.5
Air supply pressure, psig	20-140	20-140	20-120
Electrical power req'd, amps at 115 VAC (A)	0.5 (w/optional displacement sensor)	0.5	10
Electronics and software	None	Control software and electronics for active force trim control	Control software and electronics for active horizontal tracking
Typical applications	- Dynamic testing of structures - Vibration isolation - Pre-loading of test articles - Human-rated zero-gravity simulation	- Line-of-sight maintenance in beam pointing applications - Multi-axis payload pointing and disturbance generation when incorporated into CSA's custom line of hexapods	- Ground based testing of antenna reflectors, solar arrays, deployable ion thrusters, magnetometer booms - Gravity offloading of walking human subjects

These configurations are some typical examples. Numerous variations and options are possible and requests for custom versions are welcome. Typical systems use three to five identical devices although this number can be much greater for large, flexible test articles.

Ordering Information

XXXX - y - ZZZ - S

- XXXX: AGM or WAGM
- y: A for electromag actuation
- ZZZ: Payload capacity in pounds
- S: Stroke in inches

EXAMPLE: AGM-A-350-6