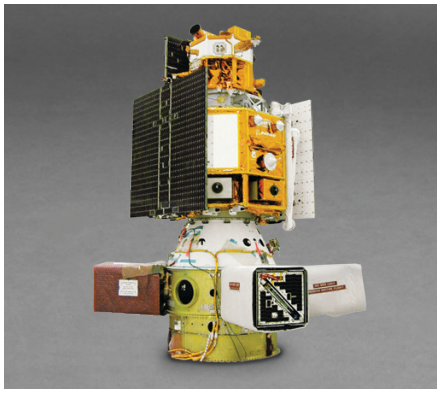
RIDESHARE ADAPTERS

MAXIMIZING SPACE ACCESS

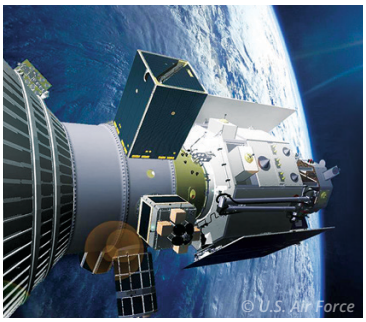


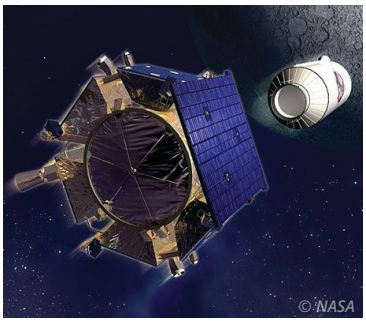
Rideshare Adapters provide space access for satellites by using excess lift capacity to facilitate multiple payloads on a single launch. Moog designed, built, and qualified the Evolved Secondary Payload Adapter (ESPA), and this development spurred Moog's wider product line of adapters for small satellites of all sizes.

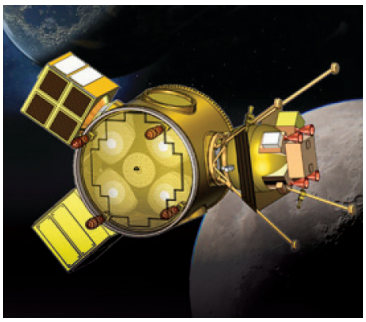
Moog was an early developer of Rideshare Adapters for small satellites and demonstrated the concept on the DoD Space Test Program STP-1 Mission on Atlas V. NASA used ESPA as a propulsive Rideshare Adapter on the launch of the Lunar Reconnaissance Orbiter (LRO); after the LRO entered lunar orbit, ESPA was the structural hub of the LCROSS lunar impactor.

Previously, Moog teamed with Redwire LoadPath on the CubeStack "Wafer" adapter, which used the Nanosat Launch Adapter System (NLAS) adapter as a baseline. The NLAS was developed by NASA Ames Research Center (ARC) to accommodate multiple CubeSats along with a primary spacecraft. Moog supported ARC in this adapter development and performed fabrication and testing of the prototype NLAS Wafer.

Moog can tailor a ride share adapter for existing and new launch vehicles per mission requirements, and we can also integrate other flight elements with an adapter. Each adapter product offers the flight-proven SoftRide interface for individual payloads or for all payloads carried by the adapter; SoftRide reduces vibration and shock transmitted to payloads during launch and separation events.







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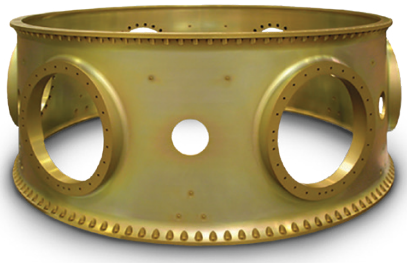
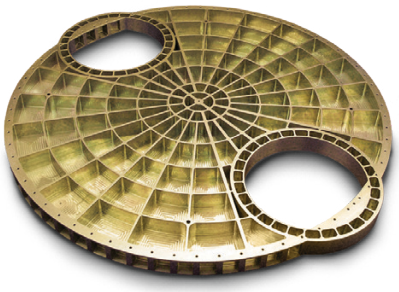
ESPA



ESPA was developed with SBIR and U.S. Air Force funding between 1998-2002. Capability was established with a qualification test in 2002, defining "ESPA class" as a 400-lb satellite with center of gravity (CG) at 20 inches or less (181 kg at 50.8 cm) and a Ø15-inch bolt circle interface. Interest in carrying larger spacecraft led to the development of the ESPA Grande Ø24-inch-diameter interface in 2004. Test programs in 2016 and 2018 established robust capabilities for both the Ø15-inch and Ø24-inch ESPA ports, and a Mass Acceleration Curve (MAC) defining ESPA spacecraft design load factors was implemented.

FLAT-PLATE ADAPTER



The Flat Plate Adapter (FPA) is compatible with ESPA, CASPAR, and various launch vehicle interfaces; it can, for example, mount two ESPA-class satellites side by side. FPA is available with SoftRide vibration isolation and it can be scaled up or down for larger or smaller spacecraft. FPAs were used in 2014 to mount ORBCOMM OG2 satellites, with discrete, i.e., non-circular, separation systems to the Ø24-inch ports of a stack of ESPA Grandes. In 2011, NASA's two lunar orbiting GRAIL spacecraft used this adapter.

CASPAR

CASPAR, the Composite Adapter for Shared Payload Rides, is a Dual-Payload Rideshare Adapter developed by Moog for the Minotaur IV Launch Vehicle featuring whole-spacecraft vibration isolation; the primary interface is 62.01" (1575mm). CASPAR accommodates two 1,500-lb satellites, or up to four ESPA-class satellites when used with one or two Flat-Plate Adapters. Moog's SoftRide and ShockRing isolation systems are easily integrated into any launch configuration.

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For More Information:
space@moog.com
www.moog.com/space

Moog Space and Defense | Moog Inc. | @Moog_Inc | @Moog.Inc

Form 500-763 091124