SPACECRAFT MECHANISMS

MOOG

OVERVIEW

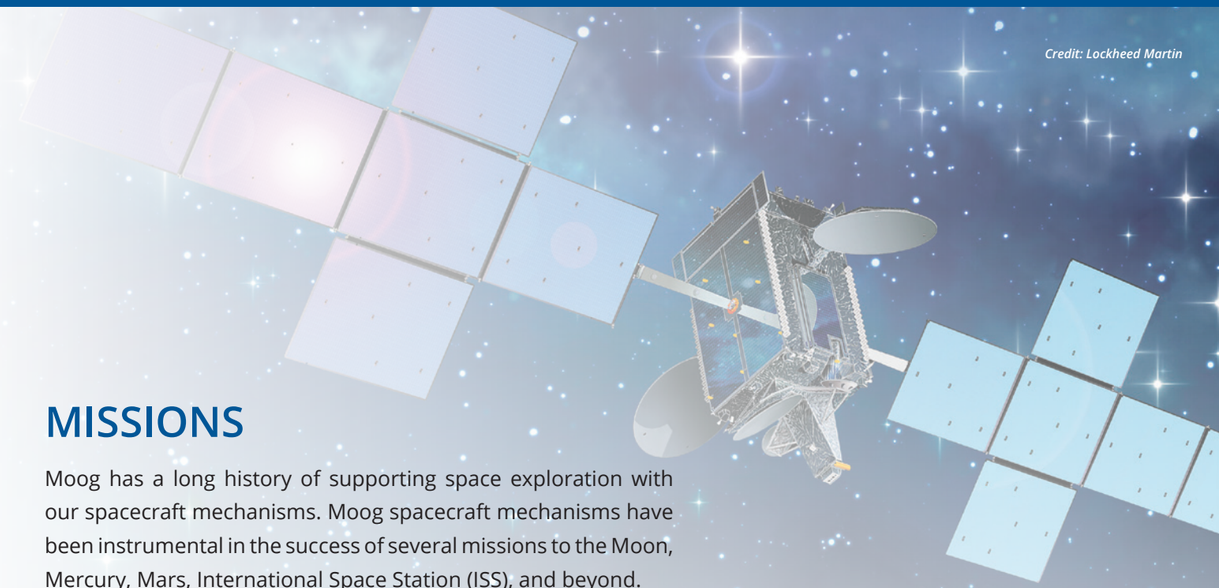
Moog has been producing mechanisms for spacecraft motion control since 1967. With origins from Apollo to present-day programs, Moog brings innovative solutions to spacecraft mechanisms technology. The 70,000 square-foot spacecraft mechanisms facility in Chatsworth, California includes a complete engineering, fabrication, assembly, and test capability. The facility has a quality system per ISO 9001:2015 and AS9100D in accordance with AS9104/1:2012. Moog spacecraft products are flexible to meet customer requirements for both commercial and government flight applications.

MANUFACTURING CAPABILITIES

- Class 100 certified laminar flow work stations
- Class 1,000 Clean Room for Bearing Processing
- Class 10,000 Optical Assembly Clean Room
- Class 100,000 General Assembly
- Extensive machining capacity, over 900 square meters of floor

TESTING CAPABILITIES

- Vibration Test Facility
- 14 Thermal-Vacuum Chambers
- 8 Thermal-Cycle Chambers
- Automated Acceptance Testing and Data Acquisition
- Cryogenic Test Capability



Credit: Lockheed Martin

MISSIONS

Moog has a long history of supporting space exploration with our spacecraft mechanisms. Moog spacecraft mechanisms have been instrumental in the success of several missions to the Moon, Mercury, Mars, International Space Station (ISS), and beyond.

NICER

The Deployment and Positioning System (DAPS) is an articulating mechanism for NASA's Neutron star Interior Composition Explorer (NICER) program consisting of a deployment and latching mechanism, a pointing mechanism, and an interconnecting boom structure. The DAPS provides a stable, high stiffness structure in the deployed and latched positions for a star-tracker system that enables (together with NICER's GPS-based absolute timing) high-precision pulsar light-curve measurements through ultra-deep exposures spanning the mission lifetime. NICER was transported to the International Space Station onboard a Dragon CRS-11 trunk via the Falcon 9 rocket.

SPACE LAUNCH SYSTEM EXPLORATION UPPER STAGE

The Propellant Utilization Mechanical Assembly (PUMA) is used to regulate liquid oxygen flow to each of the four RL-10 engines onboard the Space Launch System (SLS) Exploration Upper Stage (EUS). The first launch of the SLS/EUS was on Artemis 4. The EUS will serve as the in-space stage for all Block 1B and Block 2 SLS flights in both crew and cargo (with payload fairing) configurations.

SPACECRAFT MECHANISM PRODUCTS

ROTARY ACTUATORS

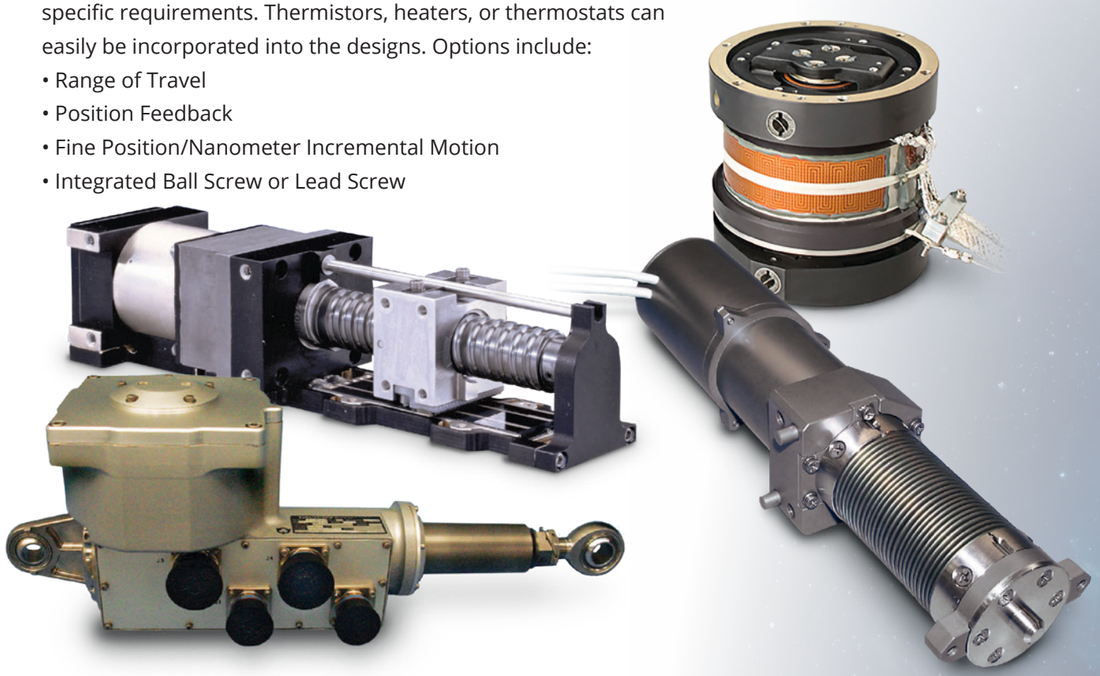
The family of Rotary Actuators is based on heritage design with a wide range of step sizes available. Options include:

- Stepper or Brushless DC Motor
- Direct Drive or Gear Transmission
- Several options for position feedback such as optical encoders, resolvers, potentiometers, and hall effect sensors

LINEAR ACTUATORS

The family of Linear Actuators allow modifications to meet mission-specific requirements. Thermistors, heaters, or thermostats can easily be incorporated into the designs. Options include:

- Range of Travel
- Position Feedback
- Fine Position/Nanometer Incremental Motion
- Integrated Ball Screw or Lead Screw



SOLAR ARRAY DRIVE ASSEMBLIES

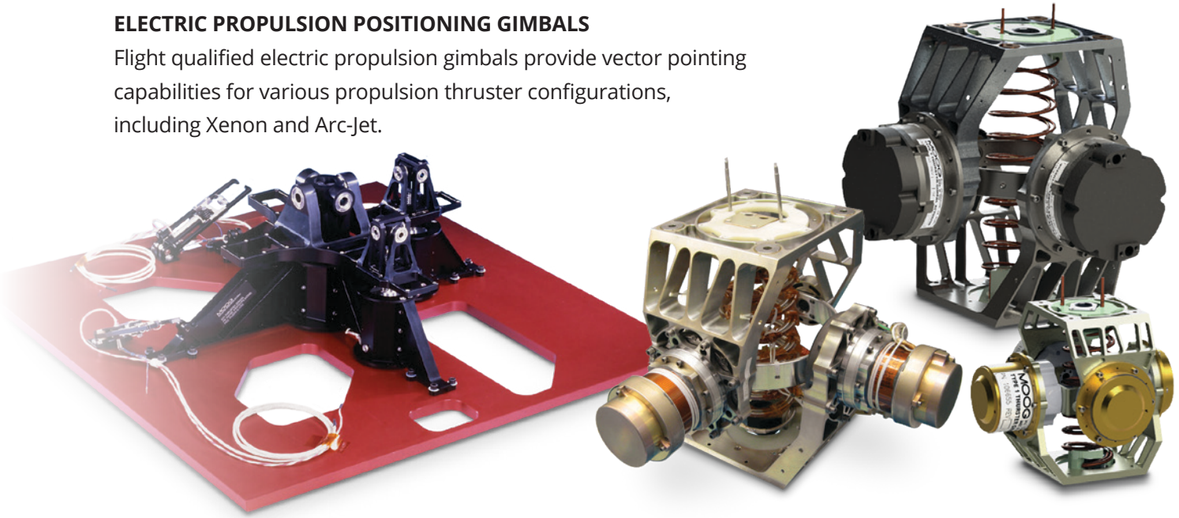
Moog offers a large selection of Solar Array Drives and Solar Array Drive Assemblies (SADAs) for a variety of spacecraft sizes, including small satellites. Options include:

- Single or Dual Axis
- Stepper or Brushless DC
- Slip Ring, Twist Capsule or Cable Management
- Resolver, Potentiometer, or Feedback Options

SPACECRAFT MECHANISM PRODUCTS

ELECTRIC PROPULSION POSITIONING GIMBALS

Flight qualified electric propulsion gimbals provide vector pointing capabilities for various propulsion thruster configurations, including Xenon and Arc-Jet.



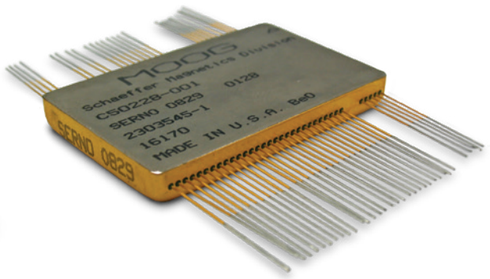
ANTENNA POINTING MECHANISMS

Moog Antenna Pointing Mechanisms (APMs) are highly-customizable to meet mission specific requirements. Either azimuth over elevation or X-Y (crossed axis) geometry are available. Options include:

- Rotary or Linear Actuators
- Stepper or Brushless DC Motors
- Encoders, Potentiometers or Resolvers
- RF & Cable Management
- Launch Locks

ELECTRONIC CONTROL UNIT

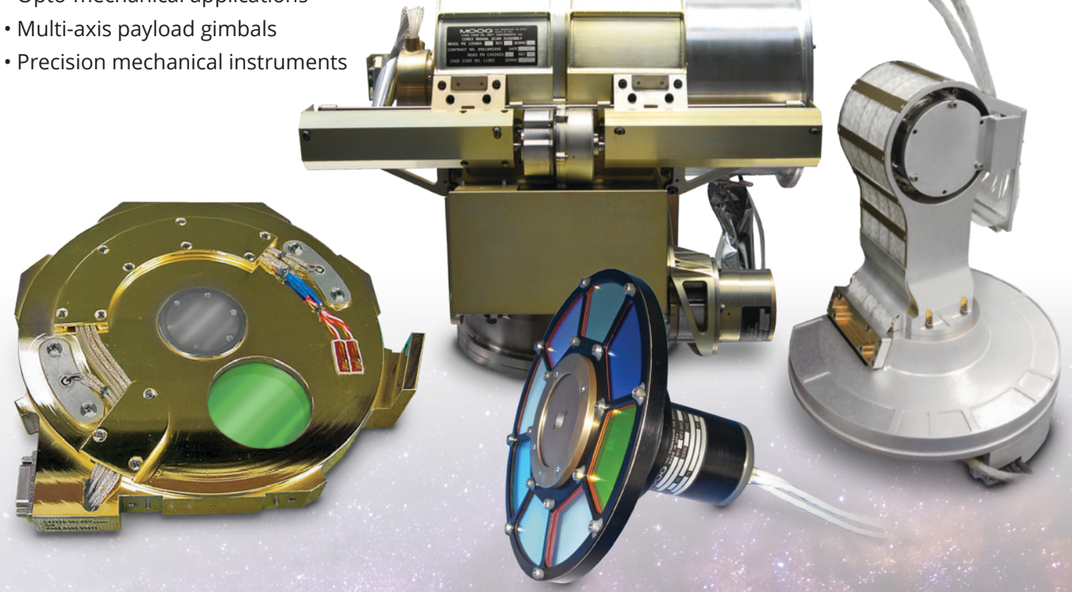
The Moog ECU is comprised of hybrid stepper motor controllers, EMI filters and analog pass-throughs for telemetry. The ECU is available in 1, 2 or 4 channel configurations.



INSTRUMENTS AND SYSTEMS

Moog Mechanisms are used on a wide variety of spacecraft instruments. These include:

- Opto-mechanical applications
- Multi-axis payload gimbals
- Precision mechanical instruments



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