

Artemis Jr. Rover - Abstract

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Ontario Drive and Gear

Background: Since 2008, NASA and the Canadian Space Agency have been participating in field deployments to demonstrate various ISRU (In Situ Resource Utilization) technologies. In February 2010, a fleet of six Juno Rovers were deployed to an analogue mission on Mauna Kea, Hawaii. Two of these rovers were linked together to form a tandem rover; this rover was used to carry the RESOLVE payload and Norcat drill. The gross weight of the resulting system exceeded 1000 kg.

Since the Hawaii 2010 deployment, a great deal of work was undertaken in an effort to create a system that was much more flight-like. The RESOLVE and Norcat drill combination were evolved to the point where the package could be mounted on a single rover, Artemis Jr., rather than on a tandem rover. Despite losing over 50 kg from the previous version, this new rover has gained several new features, including improved motors, batteries, transmissions, and traction elements.

Chassis and Suspension: Compared to the previous generation Juno Rovers, the Artemis Jr. chassis is considerably lighter and provides much more volume to ensure adequate space for control system and suspension components. Unlike the Juno Rover's extruded chassis beams, the new rover features a bonded and riveted chassis fabricated from thinner sheets of aluminum. Besides significant weight savings, this technique allowed for a greater degree of design flexibility and a more complex chassis shape. The result is a chassis frame with several times the interior volume compared to the previous generation rover. A pair of lithium-ion batteries are contained within the chassis volume and store 5.1 kW-hr of energy.

Batteries, motor controllers, navigation cameras, and the suspension actuators and mechanism are contained within the chassis frame volume, thereby protecting them from contamination and thermal extremes. As on previous four-wheel rovers, the suspension does not employ any springs or dampers, but rather relies on a geometric differentially linked suspension with active pitch control. Unlike the exposed, linear suspension system on Juno, Artemis Jr. utilizes a more compact rotary-style suspension.

Traction Drive System: As with previous ODG rovers, each pair of wheels is driven by a centrally mounted electric motor. The traction drive motors are 1200W BLDC motors supplied by Magmotor, equipped with fail safe electric brakes, and controlled by Elmo controllers. A two-stage gear reduction and single stage final drive chain reduction transfer power to each wheel pair. Whereas previous ODG rovers were fitted with fixed gear-ratio transmissions, the Artemis Jr. Rover uses a two-speed gearbox to provide a low speed that is $\frac{1}{4}$ as fast as high gear. While not likely a feature that would be used on the lunar surface, this transmission allows the rover to use a very high gear ratio (and thus very low rover speeds) for lunar mission simulations activities. Once the lunar simulation activities are completed, high

gear can be engaged to allow the rover to be moved quickly and efficiently without the use of trailers and lifting devices.

Traction Elements: While terrestrial vehicles rely almost exclusively on pneumatic rubber tires, lunar wheels must be able to survive high levels of radiation, thermal extremes, and a hard vacuum, conditions that rubber cannot tolerate. A semi-compliant metallic wheel was designed and fabricated that provides excellent low speed traction characteristics in both soft sand and rocky terrain. The 62 cm diameter wheel has a mass of 13.5 kg and is designed to operate in earth gravity supporting a maximum mass of 125 kg per wheel. Currently, this wheel has been installed on several different rovers and is being evaluated in terms of longevity and performance.

Payload Integration: While this rover was designed primarily to carry the RESOLVE payload, both the mechanical and the electrical/data interfaces can easily support a wide variety of payloads. On the top surface of the bulkhead, there are three Ethernet connections and three 28V power outlets that can provide up to 12A each. Mechanically, the chassis features a pair of lower flanges with regularly spaced through-holes. To mount the RESOLVE payload and Norcat drill, an aluminum honeycomb plate was manufactured that could be installed upon the lower flanges of the chassis frame. All payload components were mounted to the aluminum plate, which could then be quickly installed onto and removed from the rover.

Accessories: A lightweight tubular mast is attached the main bulkhead of the rover frame. A pair of adjustable struts allows the mast to be easily stowed and provides 15 degrees of angle adjustment. Rover navigation equipment such as cameras and localization components are mounted to the horizontal crossbar of the rover at a height of 1.85m. In an effort to increase the runtime of the rover, a 240W solar panel was added to the mast structure. The panel angle is adjustable from 0 to 45 degrees via a set of sliding mount clamps.

Testing: Before the 2012 Hawaii deployment, over 60 km of driving had been accumulated on a pair of Artemis Jr. rovers. A “production” rover was used for payload and electronics integration, while an “engineering model” was used to test various components and ensure that the rover would function while carrying the RESOLVE payload. A mass model simulator was constructed and installed on the engineering model to ensure that the rover was capable of carrying the payload and would remain stable while traversing extreme terrain.

Conclusion: The Artemis Jr. Rover is a lightweight and rugged mobility platform designed to carry a wide variety of payloads during analogue missions. The simple and economical design can be readily scaled to perform in reduced gravity on the lunar surface.