

## Opportunity celebrates 10 years on Mars.

It keeps going and going and going – with maxon DC motors

Ten years ago, the NASA rovers Opportunity and Spirit landed on Mars. NASA chose maxon motor to supply the 39 brushed DC motors that enable each robot to navigate the surface. Opportunity is still exploring the planet, an extraordinarily long time considering the robot was designed for a service life of only 90 days.

When the US space authority needed motors capable of dealing with the harsh Mars environment they chose to work with maxon motor. Maxon's standard DC motors, from the RE family, have had to cope with the demanding temperature fluctuations, between -120 °C and +25 °C, as well as extreme shock and high vibration. The motors have not failed despite long periods of being immobile and feature an efficiency of over 90 percent even in the dry, airless atmosphere of the Red Planet.



Fig. 1: Mars rover Opportunity. Image credit: NASA/JPL-Caltech

The rovers are six-wheeled, solar powered robots. Each wheel has its own maxon motor and they can also be found in the titanium robotic arm that has two joints at the shoulder, one at the elbow and two at the wrist, the grinding and brushing Rock Abrasion Tool (RAT), the numerous specialised on-board cameras, as well as the control mechanism.

On January 25, 2004, the Mars rover Opportunity landed in the Eagle crater. Its goal was to find evidence of past water activity and determine the distribution and composition of minerals, rocks and soils. Opportunity has already returned exceptional data showing early indications that there used to be water on Mars. The presence of water is a possible indication that the planet may once have supported life.

To date Opportunity has covered approximately 39 km, which according to scientists is the car equivalent of over 3 million km without an oil change. "The rover is in exceptionally good condition for its age", says John Callas, manager at NASA. Over the past 10 years it hasn't always been easy, sporadic dust storms have damaged solar panels and reduced power, and in 2005 the robot's wheels became perilously stuck in a Martian sand dune and required an extremely difficult manoeuvre to be freed. The 185kg robot is starting to show a few symptoms of aging, with occasional memory loss, as its hard disk shows signs of wear caused by the long period of use. All 39 brushed DC motors from maxon are still operating reliably. Opportunity is currently in its winter quarters at the edge of the Endeavour crater. Its expedition will continue as soon as its batteries have been fully recharged.

Opportunity's robot colleague Spirit, which is of identical design, sent its last signals to Earth in 2010, when it became trapped in sand alongside an ancient volcano, which prevented the recharging of the solar panels. Nevertheless Opportunity does not have to celebrate its anniversary alone, its bigger brother Curiosity has been investigating Mars for more than a year now. Progress can be followed on Twitter @MarsRovers



*Fig. 2: The RE 25 and RE 20 DC motors from maxon motor have been working on Mars for an entire decade.*