monic response. Extensive electromagnetic modeling for each channel was performed. Four channels, with 50-GHz bandwidth, were designed, each using multiple transmission line media such as microstrip, coplanar waveguide, and quasi-lumped components on 0.45-μm thick silicon. In the design process, modeling issues had to be overcome. Due to the extremely high frequencies, very thin Si substrate, and the superconducting metal layers, most commercially available software fails in various ways. These issues were mitigated by using alternative software that was capable of handling them at the expense of greater simulation time. The design of on-chip components for the filter characterization, such as a broadband antenna, Wilkinson power dividers, attenuators, detectors, and transitions has been completed.

This work was done by Negar Ehsan, Kongpop U-yen, Ari Brown, Wen-Ting Hsieh, Edward Wollack, and Samuel Moseley of Goddard Space Flight Center. Further information is contained in a TSP (see page 1).
GSC-16486-1

Qualification of UHF Antenna for Extreme Martian Thermal Environments

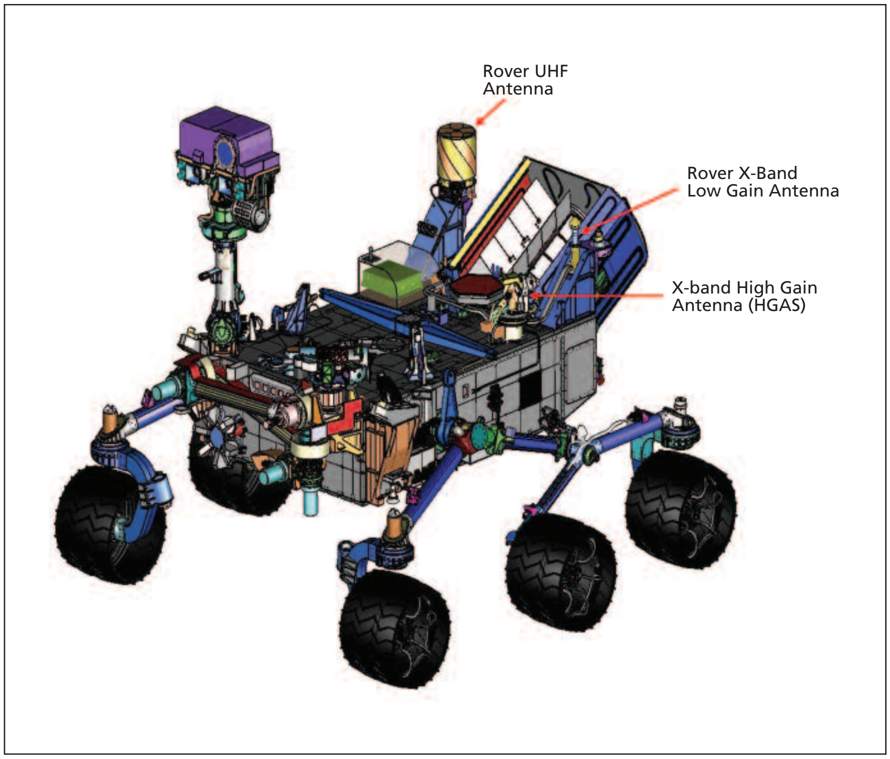
This innovation can be used in aerospace and deep space applications.

NASA's Jet Propulsion Laboratory, Pasadena, California

The purpose of this development was to validate the use of the external Rover Ultra High Frequency (RUHF) antenna for space under extreme thermal environments to be encountered during the surface operations of the Mars Science Laboratory (MSL) mission. The antenna must survive all ground operations plus the nominal 670 Martian sol mission that includes summer and winter seasons of the Mars thermal environment. The qualification effort was to verify that the RUHF antenna design and its bonding and packaging processes are adequate to survive the harsh environmental conditions.

The RUHF is a quadrifilar helix antenna mounted on the MSL Curiosity rover deck. The main components of the RUHF antenna are the helix structure, feed cables, and hybrid coupler, and the high-power termination load.

In the case of MSL rover externally mounted hardware, not only are the expected thermal cycle depths severe, but there are temperature offsets between the Mars summer and winter seasons. The total number of temperature cycles needed to be split into two regimes of summer cycles and winter cycles.



The locations of the **Rover UHF (RUHF)**, rover X-band low-gain, and rover X-band high-gain antennas on the Mars Science Laboratory rover.

The qualification test was designed to demonstrate a survival life of three times more than all expected ground testing, plus a nominal 670 Martian sol missions. Baseline RF tests and a visual inspection were performed prior to the start of the qualification test. Functional RF tests were performed intermittently during chamber breaks over the course of the qualification test. For the RF return loss measurements, the antenna was tested in a controlled environment outside the thermal chamber with a vector network analyzer that was calibrated over the antenna's operational frequency range.

A total of 2,010 thermal cycles were performed. Visual inspection showed a dulling of the solder material. This change will not affect the performance of the antenna. No other changes were observed. RF tests were performed on the RUHF helix antenna, hybrid, and load after the 2,010 qualification cycles test. The RF performance of the RUHF antenna, hybrid, and load were almost identical before and after the complete test. Therefore, the developed design of RUHF is qualified for a long-duration MSL mission.

The RUHF antenna has not been used for long-duration missions such as MSL in the past. The state-of-the-art technology of the RUHF antenna is used to develop the antennas for MSL mission survivability. This developmental test data provides the confidence in using this RUHF antenna for future NASA missions to Mars.

This work was done by Rajeshuni Ramesham, Luis R. Amaro, Paula R. Brown, and Robert Usiskin of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).
NPO-48475