



## **Description of the REMS Ground Temperature Sensor aboard MSL NASA mission to Mars**

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The Rover Environmental Monitoring Station, REMS, is part of the payload of the Mars Science Laboratory, MSL, a NASA mission to the red planet recently scheduled to launch on the fall of 2011. REMS comprises several instruments aimed at measuring ground and air temperature, wind speed and direction, ultraviolet radiation, pressure and humidity. The Ground Temperature Sensor, GTS, is a contactless multi band pyrometer. It is composed of three thermopiles measuring in different bands: 8 - 14  $\mu\text{m}$ , 16 - 20  $\mu\text{m}$  and 14.5 – 15.5  $\mu\text{m}$ . The first two bands are optimized for the higher and lower temperatures expected to be present on Mars during the lifetime of the mission. They also avoid the radiation generated by the rover itself, the Radioisotope Thermoelectric Generator, RTG, and the Sun that is reflected on the ground and reaches the thermopiles, as well as the atmospheric emission originated by the  $\text{CO}_2$ . The use of two different bands to measure ground temperature allows the estimation of the emissivity of the surface by means of colour pyrometry algorithms. Thus we may determine not only the brightness temperature but also the real temperature of the ground, i.e., the kinetic temperature. The estimation of the emissivity may serve also to detect changes in the composition of the ground, as, for example, the formation of frost. The third thermopile is centred in the  $\text{CO}_2$  absorption band, the main component of the Martian atmosphere. This allows the determination of the residual influence that the atmosphere may have in the other two thermopile's bands. The brightness temperature of the air may also be estimated from this third thermopile.

During Martian operations, the system may be degraded due to the deposition of dust over the thermopiles' filter. In order to correct for this degradation, the system includes a calibration plate, which partially fills the field of view of the thermopiles. This plate may be heated several degrees. Analyzing the signals before and during the heating process, one may estimate the fraction of the filter covered by dust. This procedure needs the ground temperature to be as stable as possible, so it will be performed just before dawn, when soil temperature changes are expected to be minimum.