Mars Microphone Instrument

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The Mars Microphone (MM) is a small (50 g) instrument to sample sounds on Mars. It forms a part of the Russian LIDAR instrument, and was developed at the University of California at Berkeley Space Sciences Laboratory under funding from the Planetary Society. It will fly on the NASA Mars 98 lander mission.

Power and telemetry resources are extremely limited, so only a few short sounds can be sent. During the hours to days it takes to send a sound sample, MM will listen. It saves the loudest sound it hears during that time to be transmitted next. Sound samples are heavily compressed using a somewhat noisy compression scheme to maximize the amount of sound we can return. Flash memory in MM is utilized to store these sounds so they are not lost when power is cycled on and off each day.

In addition to these short sound samples, a more continuous record of sound levels will be collected in the form of integrated power in 6 filter bands. These filters are integrated for a programmable interval from 1 second to 10 minutes (longer integrations give more continuous time coverage with less telemetry, but with lower time resolution). Five of the six filters divide the sound spectrum, each filter covering about an octave. The sixth filter gives the total power in the instrument pass band.

The system has two basic modes: High Frequency (HF) and Low Frequency (LF). In HF mode, the system samples sounds at 20 kHz, while in LF mode, the sound samples are taken at 5 kHz. The filter bands also shift so that the top filter goes to the Nyquist frequency (10 kHz and 2.5 kHz respectively). Sound samples last 2.6 seconds in HF mode, and 10.6 seconds in LF mode. These modes can be selected by ground command, in response to what we see in the first few sounds.

The instrument has a 12 bit dynamic range in its Analog to Digital Converter. This is augmented by a programmable gain stage which can be commanded from the ground to give 1x, 4x, 16x, or 64x gain boost to the signal. This allows us to respond to a wide range of possible sound levels on Mars.

The ADC, digital filters, and processing, and LIDAR interface are implemented in an RSC-164 from Sensory Circuits, which is a general purpose microcontroller designed to do speech recognition. Three memories are used in conjunction with this controller: an 8 Kbyte PROM to store code and tables, a 512 Kbyte RAM to store data temporarily, and a 512 Kbyte Flash memory to store information when power is removed. Together with a small Electret microphone and preamplifier, this is the complete MM system. These parts are mounted on a 2” square printed circuit board in a 2” by 2” by ½” box.

The MM communicates with the LIDAR over a three wire serial interface. This interface is used to send time and operating mode information to the MM, and to receive telemetry packets from MM (on request). MM is powered by a regulated 5 volt service

provided by LIDAR. A complete description of the MM to LIDAR electrical and mechanical interface can be found in the "Mars Microphone to LIDAR Interface Specification Document" (David Curtis, U.C.Berkeley).

A PC running software based on LabView was used as a LIDAR simulator in the instrument development process. The PC can control the instrument, and decompress and display the data. It can also play the reconstructed sound samples (which have been converted to '.WAV' files). With some simple modifications and additions this setup can be used to analyze the data after the instrument has been mated to the spacecraft. Alternatively, the decompressed data can be passed on to more sophisticated display programs like IDL for analysis.

Mars Microphone Block Diagram