

Development and On-board Testing of High Sensitivity MEMS Accelerometers for Seismic Activity Studies

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Seismology is the best geophysical tool to determine the internal structure of planets and seismometers are the instruments used to gather the data to enable the studies. In planetary missions, it is always important to develop miniature, low power consuming instruments with its performance specifications defined to meet the scientific goals. Instrument for Lunar Seismic Activity studies (ILSA) is one such instrument realized at LEOS with objective of recording seismic signals from the lunar surface that has been flown as a payload in Vikram, Chandrayaan-2.

ILSA is an instrument based on Micro Electro Mechanical Systems (MEMS) technology capable of measuring ground acceleration due to quakes along three axes. The instrument has MEMS based sensing element indigenously developed at LEOS. The sensors have been fabricated using single crystal silicon bulk micromachining technology and employs capacitive sensing principle. There are two sensors designated as fine range and coarse range sensors along each axis. These two sensors along with its front-end electronics are packaged in a Hybrid Micro Circuit (HMC) package and has been qualified for the Chandrayaan-2 mission. The instrument can resolve acceleration of 100 nano-g $\text{Hz}^{-1/2}$ at 40 Hz bandwidth. The entire range of operation of 0.5 g ($g = 9.8 \text{ ms}^{-2}$) is met with the help of fine and coarse range sensors. ILSA weighs around 1.8 kilograms and requires power less than 5 Watts. The instrument has been tested and calibrated on ground to demonstrate the major performance specifications. ILSA has been tested on board Chandrayaan-2 spacecraft where it recorded the structural vibrations experienced at the location of mounting during orbit maneuvering operations on orbiter-lander composite and on lander alone. The data could be precisely correlated to the various events associated with the operations. The paper presents the basic details of ILSA, testing and calibration on ground and onboard performance recorded by it during its various phases of operation in the Chandrayaan-2 mission.