Qualification Test Program for CCM and Prototype Flight Model

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The corner cube mechanism (CCM) engineering qualification model has completed its test program. The flight models have been assembled and will commence their flight acceptance test campaign before their integration in the interferometer assembly for the Meteosat Third Generation satellites.

The corner cube mechanism (CCM) of the infrared sounder (IRS) for the Meteosat Third Generation (MTG) satellites completed an extensive qualification test campaign to show that the high-precision mechanism can meet stringent requirements for operation in the harsh environment of space in geostationary orbit.

The qualification test program was performed at both component/sub-system level and mechanism level. One of the critical components at sub-system level is the voice-coil actuator supplied by Cedrat Technologies (F). A lengthy qualification program was undertaken with the supplier to qualify the new magnets and coatings to meet specific MTG requirements for long-term storage conditions of 20 years. Typical tests included thermal vacuum cycling (100 cycles, -40°/+80°C), thermal humidity tests (95% RH, 1 bar, 45°C, 240 h), and epoxy resin adherence to validate the robustness of the various processes used.

The engineering qualification model (EQM), which is identical to the flight model (FM) version, is considered as a prototype. Performance level tests with this mechanism were performed, for example:

- trajectory generation and motion control,
- lateral deviation of the corner cube from a true straight line,
- dynamic exported forces.

The objective of the test campaign was to validate the design, manufacture, and assembly processes of a mechanism that is as representative as possible of the final flight version.

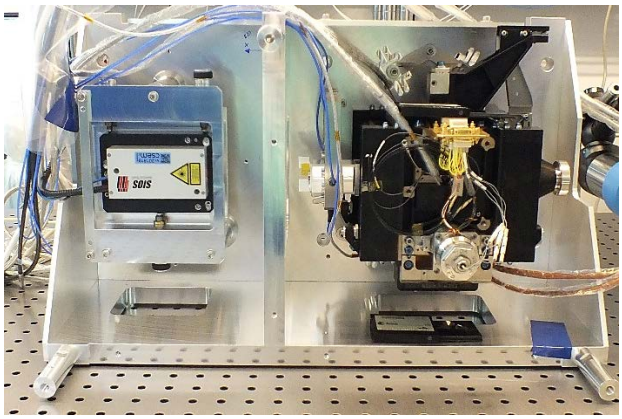

Figure 1: EQM mounted on performance test bench with interferometer in ISO5 (Class 100) cleanroom conditions.

The critical performance parameters measured during these tests were the mobile mirror lateral shifts and the speed stability. The maximum lateral deviation (parabolic shift) for a stroke of 18 mm (±9 mm) was measured at 1.7 µm in Z and 1.2 µm in Y compared to the 2-µm specification (±5 mm stroke).

Mechanical vibration tests simulate the extreme noise and vibration environment generated during the rocket launch. The delicate mechanism is in a launch locked configuration in order to ensure that it will survive the vibration loads. The EQM survived the random profile vibration tests and shock tests in all three directions. Following the environmental tests, the performance tests were repeated and a close inspection of the launch locking device critical surfaces was made. No degradation was noticed.

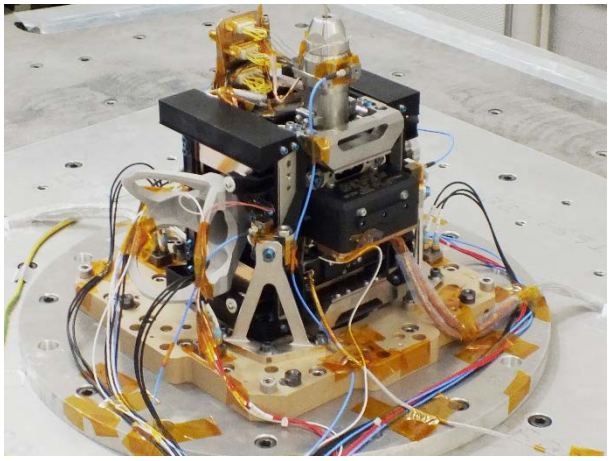

Figure 2: EQM instrumented and mounted on vibration shaker table.

The last series of tests were performed on a micro-vibration test bench that is used to measure the exported forces of the CCM while in operation and to inject a simulated spacecraft disturbance noise profile. While the mechanism was displacing the corner cube at a speed of 1 mm/s, during the reversal stroke, the forces exported to the instrument were measured as 7.2 mN.

With the injected micro-vibration disturbance profile, two speed stability parameters were measured:

- the absolute value of speed error during the dwell time measured at 0.73 mm/s (spec: 0.25 mm/s)
- the standard deviation of speed error during dwell time measured at 0.29 mm/s (spec: 0.06 mm/s)

Even though these values are out of specification, the results were expected since they are directly proportional to the injected disturbance levels. The injected disturbance is a sum of various satellite sub-system contributions, such as cryo-coolers, thrusters, and reaction wheels, which are being reviewed at satellite level to determine budgets and margins.

In parallel with the EQM qualification, the manufacture and assembly of the two FMs began and they are now at CSEM premises for the integration of sub-systems prior to the start of the FM acceptance test campaign.

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