

Trial by vacuum brings next Galileo satellites closer to launch

June 15 2012



The fourth Galileo In-Orbit Validation flight model satellite, FM4, pictured at the start of thermal vacuum testing at Thales Alenia Space Italy's facility in Rome in May 2012. The third Galileo flight model, FM3, had already undergone this testing. Credits: ESA/EADS Astrium - R. Kieffer

(Phys.org) -- The next two Galileo navigation satellites have now endured the harsh vacuum and temperature extremes of space on the way to their scheduled 28 September launch.

The fourth [satellite](#) completed 20 days of thermal vacuum testing at Thales Alenia Space [Italy](#)'s plant in Rome at the start of June. The third satellite completed the same tests the previous month.

“These two satellites are almost identical to the first two Galileo satellites that were launched last 21 October,” explained ESA’s Nigel Watts.

“So we don’t need to carry out full-scale qualification tests because we already know from our in-orbit test campaign that the design performs to our expectations.

“Instead, what we are carrying out is acceptance testing: checking the workmanship, performance and readiness to launch of these new satellites.”

Thermal vacuum testing involves placing each satellite into a vacuum chamber and pumping out all the air. Its external surfaces are then variously heated and cooled while the satellite is operated.

With no air in orbit to moderate temperatures, any part of a satellite in sunlight can become extremely hot, while those parts in shadow or facing deep space grow extremely cold. Critical systems must be kept within a set temperature range, however.

“To give an idea, Galileo’s laser retroreflector on its exterior reached -110°C during the cold phase of testing,” said Guido Barbagallo, Galileo thermal engineer.

“Meanwhile, the navigation high-power amplifiers could be driven to more than $+40^{\circ}\text{C}$ during the hot phase.”



The first two of four Galileo In-Orbit Validation satellites were launched on 21 October 2011. Credits: ESA - P. Carril

Like most satellites, Galileo's uses a variety of methods to maintain its temperature range, including multi-layer insulation, heaters, heat pipes relying on evaporating ammonia to shift heat, and radiators to dump waste heat out to space.

Galileo's passive hydrogen maser atomic clock at the heart of its navigation services is precise to a second in three million years.

But it requires extremely stable thermal conditions to achieve this. Its operating temperature needs to be regulated within a single degree, though in practice a tenth of that can be achieved.

"The passive hydrogen maser is mounted on a 3 mm-thick aluminium plate to help hold a uniform temperature, with waste heat finally radiated to space from the external satellite surface," added Guido.

The atomic clock and the mounting plate are wrapped in multi-layer insulation and attached to the top panel of the satellite, which is itself kept permanently out of the Sun.

Provided by European Space Agency

Citation: Trial by vacuum brings next Galileo satellites closer to launch (2012, June 15) retrieved 17 July 2024 from <https://phys.org/news/2012-06-trial-vacuum-galileo-satellites-closer.html>

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