

# Darpa chip-scale atomic clocks aboard International Space Station

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Atomic clocks are the most accurate frequency standard and timing devices in the world. Their range of uses include being the international standard for timekeeping, managing broadcasts and satellite positioning, navigation and timing (PNT). Traditional atomic clocks are too large to be placed onboard small satellites so a downlink with Earth is needed for the accurate PNT required for space operations.

Chip-scale [atomic clocks](#) (CSAC) were first developed by DARPA and the National Institute of Standards and Technology (NIST) in 2004. These devices are smaller than traditional atomic clocks by a factor of 100 (down to about the size of a computer chip) and are more power-

efficient by a factor of 10. Although CSACs are now commercially available, they have not yet been applied to space technologies.

On October 27, 2011, Progress 40 launched from Baikonur [Cosmodrome](#) carrying two DARPA CSACs, the first ever into space. The CSACs will soon be tested on board the [International Space Station](#) (ISS) in support of DARPA's Micro-PNT program. The chips will be inserted into bowling-ball sized satellites on the ISS called Synchronized Position, Hold, Engage and Reorient Experimental Satellites (SPHERES). Once the chips have been validated as operational, the SPHERES will perform a synchronized maneuver through the ISS cabin. After the experiment, the chips containing the CSACs will be removed and tested against the atomic clock onboard the ISS.

“DARPA hopes that testing confirms that chip-scale atomic clocks can operate in orbit with the level of accuracy for which they were designed,” explained Andrei Shkel, DARPA program manager. “A successful test after transportation, launching and [space operations](#) will mean that CSACs are one step closer to being integrated into future space platforms. Such integration should allow various space platforms more autonomy in positioning, navigation and timing.”

Provided by DARPA

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