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The ACES MWL instrument: activities status and test results

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The MWL instrument on-board ACES provides the essential radio-link to compare clocks space-to-ground with fractional frequency instability and inaccuracy in the 1E-17 range.

Mission analysis, link-budget, thermal and structural constraints, and interfaces with the ISS have been intensely revisited at ACES system and MWL sub-system level.

A new MWL dedicated test bench setup has been established in a class ISO8 cleanroom at Airbus premises in Friedrichshafen, close to the location of the ACES payload. The setup consists of the MWL flight segment (FS) proto flight model (PFM) electronic unit (EU), the FS engineering model EM2 EU, the GT2 EU connected via the MWL RF Electronics Ground Support Equipment (EGSE). The equipment provides the 100MHz and the 1PPS time references for the subsystem tests derived from an ultra-stable oscillator. Furthermore, the ACES reference maser is co-located to the test bench to support upcoming tests at ACES system level. The MWL RF-EGSE provides Ku-Uplink, Ku- and S-Downlink signal generators which can mimic the amplitude, range and Doppler frequency variations of the microwave signals along the International Space Station (ISS) orbit. Additionally, the European Laser Timing (ELT) optical link breadboard is installed and can be operated with MWL FS PFM or EM2 in constant delay or dark count rate configuration not requiring any laser source for tests.

MWL RF-EGSE calibration has been completed in the new test bench configuration. MWL FS and GT test setups and procedures to verify instrument function, calibrations and performance have been established. Ku-band and S-Band signal acquisition/locking and phase stability will be characterized.

Calibration tests have been conducted to characterize internal delays, AM/PM conversion effects, and group delay using the FS EU or GT EU internal test loop translator (TLT). Tests are in preparation to characterize signal acquisition/locking performance under static and dynamic conditions using the generated MWL link signals from the RF-EGSE.

MWL telemetry (TM) and housekeeping (HK) data conversion and post processing toolchain has been established and is in continuous refinement based on the ACES mission baseline interfaces.

MWL FS and GT2 measurement results from 2022 debugging test runs will be presented.