µHoubolt Final Static Fire Test Protocol

30.09.2022

LEAD	MISSION CONTROL	PAD	RANGE SAFETY	FIREFIGHTER
Georg Mikula	Markus Pinter	Daniel Frank	Laurens Tanzer	Bernhard Hansemann

TESTTYPE	Static Fire Propulsion test
TESTGOAL	Verify correct function of finalized propulsion system
CHANGES	Rebuild of flown system, no changes
FAILS AND LEARNINGS	Propulsion performance sufficient, thrust measurement faulty

Test summary

On 30.09.2022, a static fire test of the final propulsion system was executed. The design of the system was before proven in numerous static fire tests and a test flight, but the test flight led to a destruction of the vehicle. The goal of this test was to verify the performance of the newly built propulsion system, which aims to closely resemble the old one.

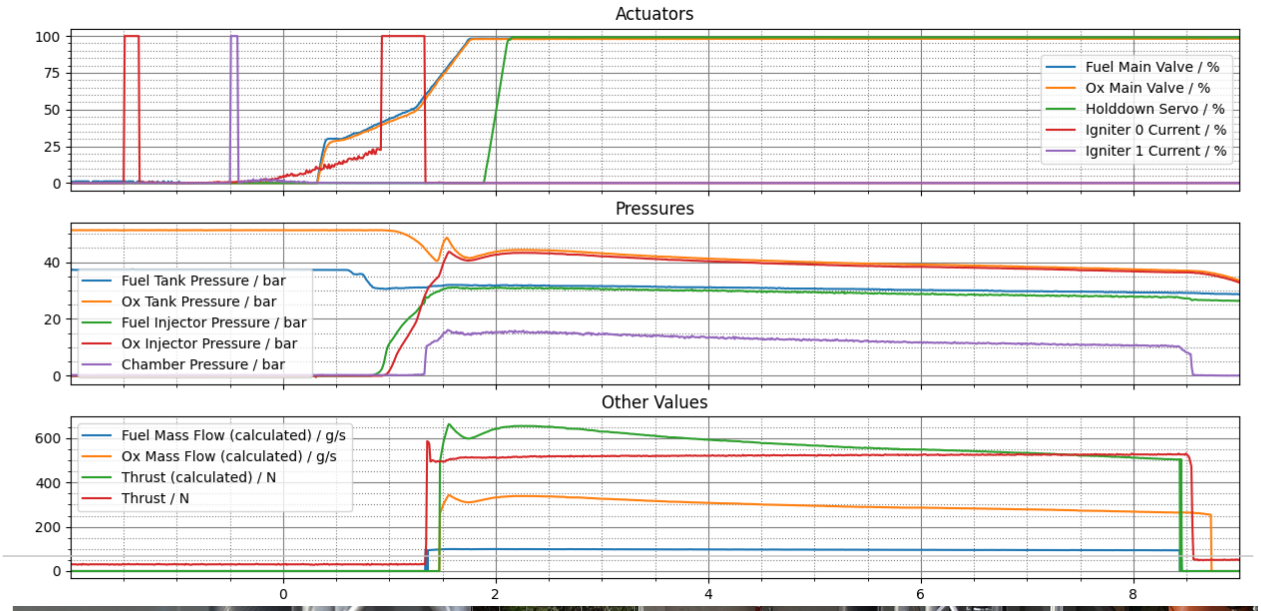
The Propulsion system was integrated into the body tube, so the parts missing for a complete vehicle were the fincan, the payload, avionics and recovery stack and the nosecone. In addition to the three propellant tank and chamber pressure sensors that will be used in flight, two additional injector pressure sensors were installed, they can be seen sticking out in the images.
One of them interferes with the automatic disconnection of the oxidizer fill umbilical, it was therefore disconnected manually in this test. The two pressurant fill umbilicals were remotely disconnected, as per the standard launch procedures.

On the launch pad, the holddown system was replaced with a thrust measurement system and the vehicle was additionally secured by two more methods to make a flyaway impossible. The servo actuating the holddown was placed in the cameras view to verify its function.

The launch preparation followed the standard procedures and the propulsion avionics were running flight ready firmware, leading to a realistic test.

The test went well and the data shown below looks mostly nominal.
The igniters fire 2-3s before the main valves open to get them to burn well. The main valves cross the opening point slowly to avoid hard starts. Shortly after, the holddown servo moves to release the rocket if the chamber pressure is nominal.
The pressure values look as expected with the injector pressures rising to almost the tank pressures when the main valves open. The chamber pressure rises to slightly above 15bar before slowly dropping as the ablative throat burns away.
The injector pressures are used to calculate propellant mass flows using models refined in previous tests, the calculated total ejected propellant mass correlates to the calculated propellant mass based on tank volumes and the propellant's density in the tank after filling. The mass flows are then used to calculate an expected thrust.
The measured thrust does not quite meet the expectations and oddly rises during the burn, but this is due to a problem with the thrust measurement system that has been seen before. Even when assuming an engine efficiency much lower than in previous tests (done for the plot below), the thrust is calculated to have been over 600N in the beginning.

Diagrams and Pictures



Signature 1

Georg Mikula

Signature 2

Markus Pinter

Signature 3

Daniel Frank