Aerospace Europe Conference 2023
Joint 10th EUCASS – 9th CEAS Conference

Abstract #XXX *(to be filled by the organizers)*
Preferred Topics: FDGNCAV / STUDENT / NEWSPA
Corresponding author: BONNY Robin
e-mail of corresponding author: robin.bonny@alumni.epfl.ch
Type: Oral
Status of corresponding author: Student
For student corresponding author: student member of one of the following:
~~3AF / AAAR / AIAE / AIDAA / CzAeS / DGLR / FTF / NVvL / PSAA / RAeS / SVFW / EUROAVIA~~

Title

Development of a Modular Half-Duplex Frequency-Agile X-Band Transceiver for CubeSats and Robotic Spacecraft

Authors

Robin BONNY [1], Martin Simik [2], Juliette Challot [3], Hannes Bartle [4]*

** Corresponding author*
[1] EPFL Spacecraft Team, 1015 LAUSANNE, Switzerland, robin.bonny@alumni.epfl.ch
[2] EPFL Spacecraft Team, 1015 LAUSANNE, Switzerland, martin.simik@alumni.epfl.ch
[3] EPFL Spacecraft Team, 1015 LAUSANNE, Switzerland, juliette.challot@alumni.epfl.ch
[4] ClearSpace, 1020 RENENS, Switzerland, hannes@clearspace.today

Abstract

The EPFL Spacecraft Team is developing the CHESS (Constellation of High-Energy Swiss Satellites) mission, foreseen to launch in 2025, a constellation consisting of two 3U CubeSats to study the chemical composition of Earth's exosphere, using time-of-flight mass spectrometry. In addition to a bidirectional UHF link, the satellites shall downlink the collected science data using a dedicated X-band transceiver. Given that the CubeSats are targeted for purely scientific and educational goals, the amateur frequency range from 10.45 to 10.50 GHz [1] has been selected for operation. This amateur band provides sufficient bandwidth while considerably simplifying the frequency coordination process. As there is currently no off-the-shelf equipment available for this band, and the overall platform development for the CHESS mission is being conducted in-house, a custom solution for the transceiver is being developed.

The transceiver architecture presented in this contribution leverages SDR technology for easy adaptation to different applications. The selected SDR transceiver IC is coupled with a custom RF front-end to attain the target frequency beyond 10 GHz via a heterodyne approach, employing additional filtering. Modulation/demodulation and coding/decoding are performed on an adjacent Xilinx SoC. Given the modularity of this architecture, the desired frequency range can be changed by substituting a small number of components on the RF front-end, with the backbone remaining unchanged and without requiring a complete redesign of the system.

This modular technique can potentially be a good fit for future robotic spacecraft missions. Active Debris Removal (ADR) or Lifetime Extension (LE) services, for example, being developed by the EPFL Spin-off ClearSpace, require flexible communication systems that allow in-flight reconfigurability. There are currently no low-cost, frequency and transmit power agile Telemetry and Telecommand (TMTC) systems on the market. The Software Defined Radio (SDR)-based approach combined with modular front-end architectures at different frequency bands can provide a highly versatile solution for these types of missions.

References

[1] ITU Radio Regulations 2020, Chapter II – Frequencies