FLEXIBLE AND RECONFIGURABLE TT&C TRANSPONDER FAMILY WITH PAYLOAD DATA TRANSMISSION

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Abstract

Communication systems play a very important role in every spacecraft. A Telemetry, Tracking and Command (TT&C) transponder is a critical component, allowing communication between spacecraft and ground station. The spacecraft is controlled by ground operators via telecommands, while it transmits its status telemetry back to the ground station. At the same time, the position of the spacecraft is constantly tracked via ranging tones. Next to operational data communication, a spacecraft can gather a large amount of scientific data that needs to be transmitted to Earth. This so-called payload data transmission (PDT) requires a different hardware configuration depending on the required data rate.

Currently, separate communication systems are being used for TT&C and PDT and both are being redesigned according to a mission's specific requirements. This requires a lot of effort in terms of customization and qualification.

Under a European Space Agency (ESA) contract, Antwerp Space is developing an innovative, flexible and reconfigurable transponder product family that is compatible with a large number of diverse missions, such as deep space, near Earth, Earth Observation and navigation. Using a modular approach, this transponder can be tailored to a specific mission without the need for hardware modifications. Furthermore, it supports both TT&C and PDT.

This paper describes the development of the Elegant Breadboard (EBB), a model of the intended transponder that is used to perform electrical and functional verifications. Evaluation of the EBB shows that the modular architecture is compatible with almost all future space applications, improving on the design of new communication systems.

The EBB is based on the baseline configuration of the transponder product family. It is an integration of the RF receiver and transmitter with the digital baseband board and the FPGA. To verify the flexibility and re-configurability of the intended transponder, the EBB includes almost all functions and operating modes, either in software or firmware, needed in target applications.

Developing the EBB allowed a next iteration on the estimation of mass and volume budget, as well as the power budget. First integration test results prove to be very promising. The software defined radio (SDR) with the state-of-the-art FPGA allows to enhance the transponder's performance significantly, e.g. high data rates needed for PDT. Its flexibility allows the implementation of practically any of the newest modulation and coding schemes.

Currently, Antwerp Space is testing the end-to-end performance of the EBB, thereby finalizing the current phase of the project. Based on the equipment modelling and bread-board measurement results, the phase shall conclude with the definition of the implementation baseline for the next

phase, where an engineering model (EM), an engineering qualification model (EQM) and eventually a flight model (FM) will be developed. The board and layout of the EBB will not be the same as for the FM, but its functional behaviour is fully representative for the FM. Antwerp Space is ready to tackle the milestones in developing a next-generation highly flexible transponder flight equipment.