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HIGHLY FLEXIBLE TELEMETRY, TRACKING AND COMMAND TRANSPONDER SYSTEMS FOR  
EARTH OBSERVATION AND TELECOMMUNICATION SATELLITE CONTROL

**Abstract**

Telemetry, tracking and command (TTC) transponder systems are used on-board of satellites for remote control, telemetry acquisition and ranging purposes during the complete satellite life.

New communications frequency bands were allocated for TTC applications in order to cope with the growing number of satellites. The growing use of electrical propulsion system leads to extended launch and early orbit phases (LEOP). In order to be able to command the satellites during the LEOP phase it is required to switch the TTC uplink frequency over a wide range. Enhanced frequency agility is also required for satellite reallocation and replacement. Due to the increasing complexity of satellite busses and communication payloads, it is expected that the TT&C data rates will increase further, calling for more bandwidth efficient access schemes. When a large number of satellites has to be managed in a limited frequency band, direct sequence spread spectrum (DSSS) schemes are attractive since many links can be operated at the same carrier frequency without coordination. DSSS schemes are already used for satellite constellations, e.g. Galileo. Utilization of DSSS schemes for management of GEO satellite clusters and hosted payloads is reflected in the newly adopted ETSI EN 301 926 standard.

For the growing number of Earth Observation satellites, it is crucial to reduce the congestion in S-Band and to support higher TC data rates. The ITU agreed a new frequency allocation at the World Radio Conference (WRC) 2015. In particular ITU has allocated the band 7190-7250 MHz for the TC uplink missions, in addition to the existing S-Band uplink allocation. This opens up a very promising approach, namely to target a cost-effective solution by combining the X-Band TT&C transponder and high rate downlink transmitter into a single equipment. This will be beneficial in terms of a positive impact on mass, volume and costs of the overall communication subsystem.

The modular design of the presented Transmitter and Receiver units allows easy adaption to mission specific requirements and reflects all the required features mentioned above. The units are based on a generic platform concept which can also be reused for different frequency bands.

Within the proposed paper the design of the TTC Receiver and Transmitter units will be presented in more detail. Moreover the functional capabilities and performance parameters will be shown.