# ECSS TM/TC COMPONENT WITH SPACEWIRE RMAP INTERFACES

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**Short Paper**

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**ABSTRACT**

Traditionally the implementation of telemetry encoders and telecommand decoders for space has been made in hardware, at least for the last two decades. With the availability of more processing power (e.g. LEON3-FT - 32-bit fault-tolerant SPARC V8 processor), more of the encoding and decoding tasks can be moved to software, allowing flexibility for adapting the system to on-going standardization efforts. The return of software-based decoders in space was made in late 2009 with the launch of a European technology demonstrator satellite.

The ECSS and CCSDS compliant TM/TC flight device is implemented in the anti-fuse RTAX2000S technology from Actel, which is radiation hard, latch-up immune, and has single-event upsets protected flip-flops. The on-chip (and off-chip) memories are protected against single-event upsets by means of BCH-based EDAC.

The TM/TC FPGA device features the following functions:

- CCSDS / ECSS compliant Telemetry encoder:
  - Virtual Channels implemented in software, via a SpaceWire RMAP I/F
  - Virtual Channels implemented in hardware, via two SpaceWire RMAP I/Fs
  - Reed-Solomon and Convolutional encoding in hardware
- CCSDS / ECSS compliant Telecommand decoder:
  - Multiple Virtual Channels implemented in software, via a SpaceWire RMAP I/F
  - One Virtual Channel implemented in hardware, with parallel pulse commands
  - Start sequence search and BCH decoding in hardware

The mix between hardware and software implementation carters for a safe and sound system at the same time as flexibility is provided to support upcoming standards.

The novelty of this device is that the communication between the telemetry and telecommand system and on-board computer, as well as payload, is done by means of the Remote Memory Access Protocol (RMAP) over SpaceWire links. Via RMAP read and write commands the device status can be observed and it can be controlled in a safe (verified-write command) and standardized way (ECSS standard). For software telemetry and telecommands, complete transfer frames can be moved between the device and on-board computer. For hardware telemetry, complete Space Packets can be sent from payload to the device. The RMAP target implementation in the FPGA requires no local processor, simplifying the design and releasing logic resources. The CCSDS / ECSS telemetry and telecommand software stacks are handled over RMAP.

The full paper will present the TM/TC device in detail; covering the RMAP enabled SpaceWire links and their usage for receiving and transmitting data to ground.