

NASA Range Safety Program 2006 Annual Report

EMERGING TECHNOLOGY LOW COST TDRSS TRANSCEIVER

The Low Cost Tracking and Data Relay Satellite System (TDRSS) Transceiver (LCT2) project is developing a cost-effective flight transceiver geared toward suborbital and launch vehicle applications. The Suborbital and Special Orbital Projects at Goddard Space Flight Center's Wallops Flight Facility initiated the effort. The reason for the development arose from a need for affordable flight hardware for smaller, lower cost missions that could realize operational savings by using the NASA Space Network to supplement or replace ground-based assets. Cost savings have been achieved by integrating the digital and analog circuits, implementing the modulator and demodulator digitally, and not requiring the level of parts selection and radiation tolerance needed for on orbit spacecraft.

Initial Development Phase

The transceiver development has been broken into several design phases. The initial phase covered development of a unit with S-Band transmit capability only, with 10 to 20 watts of radio frequency output power in the 2200 to 2300 megahertz band. The objectives of this first phase were to validate that the overall transceiver enclosure configuration, power distribution, printed circuit board mounting, and signal isolation met flight level environmental constraints. This phase was completed in April 2006.

The phase one transmitter design incorporates a Xilinx Virtex-II field programmable gate array for digital intermediate frequency signal synthesis and baseband data filtering for an optional direct radio frequency quadrature modulator integrated circuit. The unit has demonstrated radio frequency compatibility with the Space Network in both spread and non-spread modes. One unit has flown on an Air Force expendable launch vehicle to support an over-the-horizon telemetry link. Two additional units have been integrated into payloads (not yet launched) for launch and early orbit telemetry support through the Space Network.

Second Development Phase

The second development phase, which is in progress, covers development of the receiver module for processing the TDRSS forward link at 2106.4 megahertz. A radio frequency front end and intermediate frequency gain stage are being incorporated into the present enclosure configuration. The intermediate frequency will be digitized and the correlator and modulator will be implemented digitally in a Virtex-4 field programmable gate array.

A prototype is planned to be available for testing in the summer of 2007. The new transceiver board that includes the receiver functionality will also contain the hooks to interface to a command and telemetry processor—being developed by Kennedy Space Center—all packaged in a single unit. Once the fully functional transceiver has been tested and performance verified, flights of opportunity will be identified for in-flight evaluation.

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Other Related Efforts

Two other LCT2 related efforts are also planned for 2007. First, the high power S-band amplifier will be redesigned with a Gallium Nitride transistor amplifier, that will be nearly twice as efficient as the present design. Second, work is beginning on design of a Ku upconverter module that will drop into the present amplifier well. The result will be a low radio frequency power (< 20 dBm) Ku modulator that can drive a higher power external solid state amplifier or traveling wave tube. Quadrature phase shift keying data rates greater than 150 megabits per second will be achievable using the direct radio frequency quadrature modulator that is in use on the present design.

The LCT2 development team has been managed by NASA and consists of both civil servant and contractor members. The primary engineering contract support has been provided by LJT & Associates from Columbia, Maryland. Initial mechanical and thermal analysis was supported by the Instrumentation Development Group at Johns Hopkins University. Presently, the Mid-Atlantic Institute for Space Technology—a consortium made up of area government, industry, and academic entities—is providing engineering and program support.