

Miniature Optical Communications Transceiver (MOCT)

Software-defined modulator/receiver reduces power needs

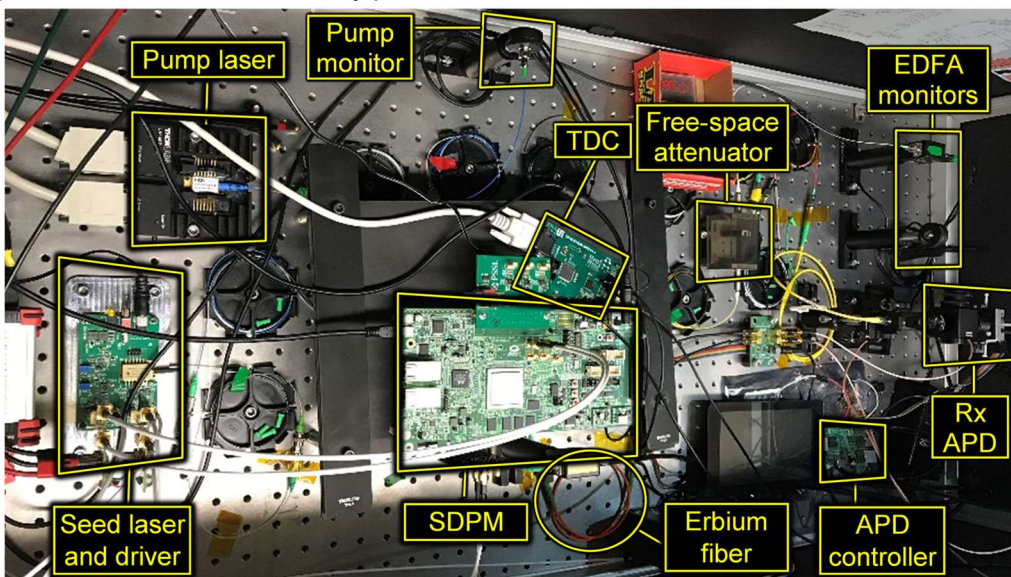
The Precision Space Systems Laboratory at the University of Florida is advancing the technology readiness of the Miniature Optical Communications Transceiver (MOCT) from TRL 3 to TRL 5. MOCT consists of a software-defined pulse modulator (SDPM), integrated laser system, and avalanche photodetection system, and is designed for optical communications between small spacecraft, including CubeSats, using a pulse position modulation (PPM) scheme. PPM uses the timing of optical pulses to encode digital information. The modulator and receiver are particularly interesting for improving small satellite communication because of the limitations on size, weight, and power. This technology can generate shorter than one nanosecond-wide 1550 nm optical pulses with better than 50 picosecond timing accuracy. The timing resolution of this system compared with previous technologies by about a factor of 2-5 indicates more bits of data are transmitted with each optical pulse. This technology can both generate and time-stamp the arrival of short optical pulses with 50 ps precision, and it simultaneously provides

power efficient communications and relative ranging between small spacecraft at the cm-level.

Since the pulse timing is generated using software-defined precision delays, it does not require a power hungry, GHz slot clock or processor. Instead, a 10 MHz chip-scale atomic clock, consuming only ~100 mW, is used to continuously calibrate the timing delay chain. The modulator is paired with a novel avalanche photodetector-based receiver with a measured 50 ps timing accuracy. When combined with a laser amplifier, transmit/receiver optics, and a precision pointing capability, this technology enables high data rates (~100 Mb/s) on power-constrained small satellite and nanosatellite platforms.

The primary objective of this project is to prepare the SDPM and photoreceiver for a subsequent flight demonstration on a pair of communicating CubeSats. Together with

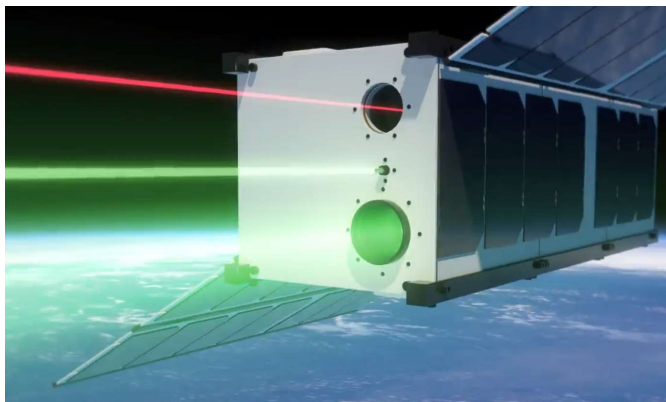
NASAfacts



Prototype MOCT Software-defined Pulsed Modulator and Seed Laser
Credit: University of Florida

our partners at the NASA Ames Research Center (ARC), and through a collaboration with Dr. Kerri Cahoy's lab at MIT, we are developing a follow-on project, with support from the NASA Small Spacecraft Technology program and the CubeSat Launch Initiative to demonstrate space-to-space laser communications, ranging and time-transfer. The flight demonstration mission, CLICK (CubeSat Laser Infrared Crosslink), will utilize some of the technologies developed under the MOCT project, including the avalanche photodetection system, chip-scale atomic clock, and the SDPM. Each transmitter will be integrated with a 6U CubeSat, and be will designed to transmit data to another CubeSat and to a ground station. The pair of optical transmitters and receivers will also provide simultaneous cm-level intersatellite position information as a side benefit.

Farther in the future, we can envision using this optical communication technology to provide high precision orbit determination for nanosatellites flying beyond the GPS sphere or to enable small satellites to provide navigation solutions and data relays to human or robotic explorers operating near the Moon or Mars. This will allow constellations of Earth orbiting nanosatellites to network with one another, to precisely correlate astronomical or Earth observations or to coordinate spacecraft flying in formation to produce a distributed aperture telescope.



Artist's rendition of the CLICK B/C CubeSat that utilizes many components of MOCT
Credit: NASA

The MOCT project is managed by the Small Spacecraft Technology Program (SSTP), which is chartered to develop and mature technologies to enhance and expand the capabilities of small spacecraft with a particular focus on communications, propulsion, pointing, power, and autonomous operations. The SSTP is one of nine programs within NASA's Space Technology Mission Directorate (STMD).

For more information about the SSTP, please visit: <http://www.nasa.gov/smallsats>

For more information on MOCT, contact:

John W. Conklin, MOCT PI
Mechanical and Aerospace Engineering
University of Florida
jwconklin@ufl.edu

Roger C. Hunter
Small Spacecraft Technology Program Manager
Space Technology Mission Directorate
NASA Ames Research Center
Roger.C.Hunter@nasa.gov

Christopher Baker
Small Spacecraft Technology Program Executive
Space Technology Mission Directorate
NASA Headquarters
Christopher.E.Baker@nasa.gov

National Aeronautics and Space Administration

Ames Research Center
Moffett Field, CA 94035

www.nasa.gov