

*Advanced Propulsion, Power, & Communications  
for Space, Sea, & Air*



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**High Performance Component Technologies for SmallSats**



**Terminator Tape™ Deorbit Module**

*Affordable Satellite Disposal for Space Debris Mitigation*

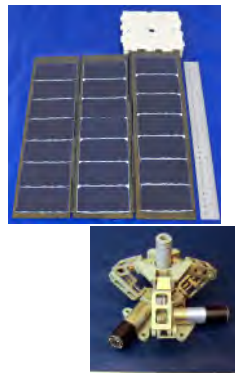
The Terminator Tape™ is a low-mass, low-cost device that provides autonomous ensured end-of-mission deorbit of spacecraft to enable cost-effective compliance with space debris mitigation regulations and requirements. Terminator Tape modules optimized for CubeSats, nanosats, and microsats are available.



**PowerCube SunMill™ Deployable, Steerable Solar Array**

*High Power Deployable Solar Panel for CubeSats*

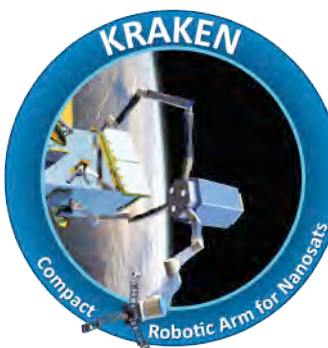
The PowerCube Solar Array™ is a 2-axis gimbaled deployable solar array designed to enable the low-cost CubeSat platform to be used to conduct high-performance, high-power missions. The PowerCube Array can provide up to 80 W peak power and 49 W OAP to a 3U CubeSat bus.



**Propulsive Electrodynamic Tether (PET)**

*Propellantless Propulsion for LEO Spacecraft*

The PET system can provide propulsive thrust for a spacecraft in Low Earth Orbit at efficiency levels comparable to Hall thrusters while consuming zero propellant. It therefore can enable spacecraft to perform very large total delta-V maneuvers with far lower mass requirements than any other propulsion system.



**Compact Robotic Arm for CubeSats & Nanosats (KRAKEN)**

*High-Dexterity Manipulator for Nanosatellites*

The KRAKEN™ Arm is a lightweight, modular robotic manipulator that enables nanosats to perform robotic servicing and assembly missions. KRAKEN arms can be configured with up to 11 degrees of freedom to provide high dexterity and precision over a large workspace. Two 1-m KRAKEN arms stow within a 3U volume.



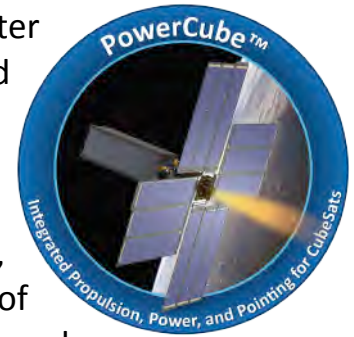
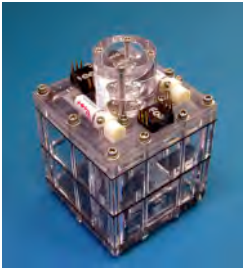


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### PowerCube™ Water Electrolysis Thruster (WET)

#### *Large $\Delta V$ Propulsion for Orbit-Agile CubeSats*

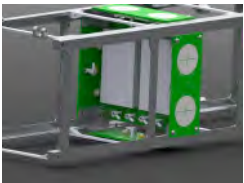
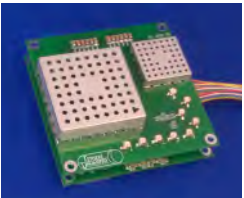
The PowerCube WET Propulsion module enables CubeSats to be launched with an inert, 'green' propellant – water – eliminating the need for stored energy or pressurized tanks that pose a risk to primary payloads. The module uses an innovative electrolysis cell designed for microgravity to process the water on-orbit into H<sub>2</sub> and O<sub>2</sub>, which it then feeds to a simple pulsed, pressure-fed thruster. The module provides 100 m/s of  $\Delta V$  per 100 mL of water for a 3U CubeSat, and is designed for low cost CubeSat programs.



## High-Performance Communications & Sensing for CubeSats

### SWIFT-RelNav *Relative Position, Synchronization, and Communications for CubeSats, MicroSats, and UAVs*

TUI's RelNav Sensor provides a completely integrated 6-axis relative position measurement solution that enables groups of spacecraft and UAV's to perform formation flight and synchronization without requiring any external reference signal. It provides ranging with accuracy of  $\leq 10$  cm, attitude to  $\leq 1$  degree, timing and frequency sync to  $\leq 1$  ns and  $\leq 0.1$  ppb, and data transfer up to 12 Mbps.



### SWIFT SDRs *Communications for CubeSats*

TUI's SWIFT software defined radio (SDR) architecture provides high-bandwidth sampling and complex signal processing capabilities over a wide range of bands through the use of modular RF front ends. For example, the SWIFT-AFSCN programmable radio enables CubeSats to communicate with AFSCN ground stations by providing simultaneous reception on SGLS and USB channels as well as S-band transmission with  $> 30$  MHz bandwidth. The SWIFT-TacSatComm enables CubeSats to communicate with standard Arm handheld radios by combining a UHF flexible waveform transceiver with a high-gain UHF antenna.



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## Mission

Tethers Unlimited, Inc.'s mission is to develop high-performance propulsion, power, and communications technologies to provide revolutionary capability enhancements and dramatic cost savings for applications in Space, Sea, Earth, and Air.

## Core Competencies

### Space Tethers and Space Deployables:

TUI is the premier source of expertise in space tether technologies. TUI has unique capabilities for design, analysis, and simulation of space systems utilizing long flexible structures for propellantless orbital maneuvering, orbit transfer, stationkeeping, and formation flight. TUI has developed several mechanisms for deployment of multi-kilometer tether structures for spacecraft, aircraft, mobile robot, and undersea applications, and has performed microgravity, flight, and orbital testing of these systems. TUI also has extensive experience in design, fabrication, and testing of deployable space structures such as solar arrays and antennas.

### High-Performance Small Satellite Component Technologies:

TUI has substantial experience in development, prototyping, testing, and on-orbit operations of technologies optimized for integration on mass- and volume-constrained space platforms such as nano-, pico-, and micro-satellites. These technologies include navigation sensors, deployable antennas, deployable solar arrays, C&DH avionics, robotic manipulators, EO sensors, actuated mechanisms, and multi-functional structures such as "Structural-MLI". In one effort, TUI designed, built, launched, and operated a three-CubeSat spaceflight experiment for a total program cost of under \$1M.



## Markets/Customers

TUI's business is R&D of innovative aerospace and defense technologies. TUI has performed successfully on over 70 contract efforts with government and industry clients, including:

### Government:

DARPA  
NASA – MSFC, ARC, GSFC, LaRC, GFC, JPL  
AFRL – PR, VS  
Army - AMC, SMDC, TARDEC, ARDEC  
Sandia National Laboratories  
Navy – NRL, SPAWAR, ONR, NAVAIR,  
NAVFAC, NFESC

### Industry:

Boeing  
Excalibur Almaz  
iRobot  
Lockheed Martin  
Millennium Space Systems  
Northrop Grumman  
Raytheon  
SRI International  
Triton Systems, Inc.

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