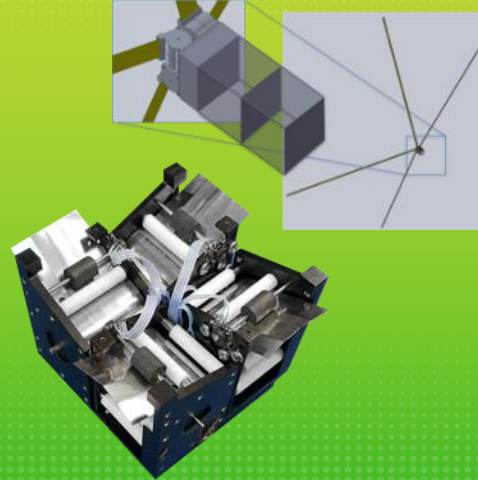




## THE PRODUCT

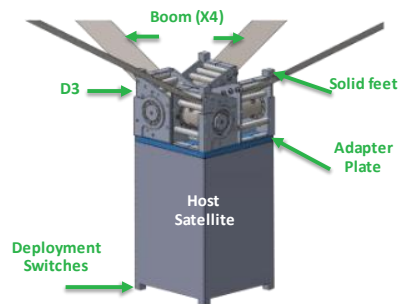
- Satisfy the FCC 'Five-Year Deorbit Rule'
- No explosion risks or hazardous materials
- Passive deorbiting at end of mission
- Cost considerably less than thrusters
- Low power use and simple integration
- Deorbit from any altitude up to 700 km
- Can replace expensive ADCS systems
- Quickly produced and replicated (90 days)
- Does not require ITAR
- Late-stage spacecraft integration



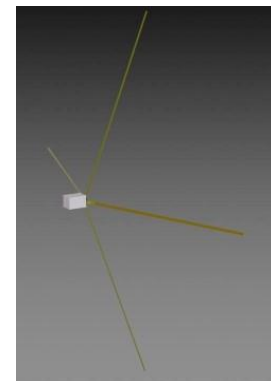
De-Orbit Drag Device (D3) attaches to existing CubeSats to facilitate de orbit of a satellite

- 180kg max
- Up to 12U form factor
- 700km max altitude
- FCC compliant (5 years)
- Supports Conjunction Avoidance
- Controlled Descent and Orbit Adjustment (after initial deployment)

## D3 DEVICE OVERVIEW



*D3 is Compatible With CubeSat Design Spec*



*D3 Installed on CubeSat*

## Orbital Lifetime Test Cases: 6U and Larger

Maximum FCC-compliant orbital altitudes with D3 :

6U → 622 km

12U → 578 km

180 kg Small Sat → 565 Km

Altitude (kilometer)	Host Spacecraft Mass (kilogram)	Reference	Host Drag Area (square meters)	Orbital Life Without D3	Orbital Life WITH D3	Compliant with FCC
400	12	6U	0.02	2.8 years	49 days	YES
	24	12U	0.04	2.8 years	84 days	
	180	SCISAT	2.81	115 days	100 days	
500	12	6U	0.02	28 years	234 days	
	24	12U	0.04	28 years	1.3 years	
	180	SCISAT	2.81	1.9 years	1.6 years	
622	12	6U	0.28	100+ yrs (never)	5 years	
578	24	12U	1.06	100+ yrs (never)		
565	180	SCISAT	14.06	31.8 years		

Notes

- Baseline commercial D3: 1.1kg and RAM area is 0.51 square meters
- CubeSat mass is 2kg per U
- SCISAT is a typical small satellite that weighs a little under 180kg. Launched in 2003 to 650km altitude and is still in orbit
- For 180kg satellites: D3 boom area grows 2x for FCC compliance

Assumptions

- 21 gravitational harmonics
- NRLMSISE-00 density model
- Moon and sun attractions included
- Cd is the standard 2.0
- Decay altitude set at 120km

## Orbital Lifetime Test Cases: 3U

Mission Definition Inputs					Orbit at End of Mission		Orbit Life after Mission End (Must not Exceed 5 Years)		Software
		No D3	With D3 pre boom deploy	With Booms Deployed	Without D3	With D3	Without D3	With D3	
					km	km	Years	Years	
3U Satellite Mass, kg		10	10.45	10.45					
Effective RAM Area Spacecraft, cm <sup>2</sup>		100	100	5246	514	514	66.8	0.8274	STK
Area/mass Ratio		0.001000	0.000957	0.050199	522	522	46.4	0.977	DAS
Years after Launch that D3 Deploys	2								
Years after Launch that Mission Ends	2								
Satellite Initial Orbit Altitude	525								
Orbit Inclination, deg	98.2								

**Notes**

- Each D3 Boom RAM area (at 70 deg from Ram axis): 1286 cm<sup>2</sup>

- 21 gravitational harmonics
- nrlmsise-00 density model
- Moon and sun attractions included
- Cd is the standard 2.0
- Decay altitude set at 120km

## Orbit Lifetime Analysis

- A drag area of 0.51 m<sup>2</sup> is needed to deorbit a 12U, 15 kg satellite from 700 km in 25 years.
- Plot shows 12U, 6U, and 3U satellite orbit lifetimes with and without the .51m<sup>2</sup> drag device (D3)

