



# KRATOS 1U: READY TO FLY CUBESAT PLATFORM JUST ADD YOUR PAYLOAD



## SUMMARY:

The EXA KRATOS 1U Spacecraft bus is a 1 step cubesat solution that allows developers to focus on the payload and its mission: It includes everything needed for the spacecraft to work and even comes VTV tested, just integrate your payload and fly.

The KRATOS SCB is completely configurable: From a modest, standard cubesat to a powerful SpaceTaxi in a 1U that can host up to 6 standard payload boards and 3 cameras delivering up to 100W of power, and LASER communications at 10Mbps. It has everything needed to fly: Onboard computer with pre-installed libraries, SDR Radio with integrated power amplifier, a powerful EPS with 4 power rails, UMPPT Solar management coupled to a fast battery charger, Deployable Multifunction Solar Arrays, automated deploy/release control to up to 4 devices, embedded monopole and dipole antennas from VHF to L band, embedded magnetorquers, temperature and sun sensors in all walls, ADCS control with integrated Z axis magnetorquer, high power batteries, radiation hardened SSD storage and even LASER communications at 10Mbps minimum.

KRATOS comes shielded with our exclusive SEAM/NEMEA-A MLI, providing a balmy and safe 10°C inside the spacecraft throughout the complete LED thermal cycle

You can add or subtract features and expand capabilities accordingly to your project budget, the main idea is that you focus on your mission, we focus on the spacecraft.

## LOTS OF POWER

Up to 100W of battery power and 32W of Solar power

## POWERFUL ONBOARD COMPUTER

Xilinx ARM9 dual core running at 733MHz

## SOFTWARE DEFINED RADIO ON BOARD

On board SDR able to handle from 70MHz to 6GHZ Full duplex with one TRX and 2 RX

## EMBEDDED ANTENNAS, MAGNETORQUERS AND SENSORS

4 Embedded monopole/dipole antennas tunable from VHF to L-BAND, 4 Magnetorquers, Sun and temperature sensors in all 6 walls

## AUTOMATIC RELEASE/DEPLOY

Release and deploy of the solar panels completely automated and room to manage 4 more user devices

## ON BOARD LASER COMMUNICATIONS

LASER emitter capable of 10Mbps download speeds

## CHOICE OF PATCH ANTENNAS FOR HIGHER BANDS

Active patch antennas available as optional from 5.5 to 6.5 dBi from L-Band to C-Band

## AMPLE ROOM FOR PAYLOADS

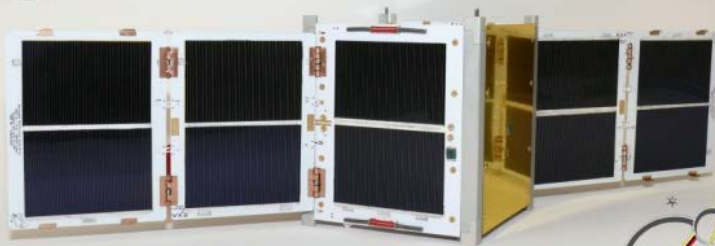
Room for 6 standard payload cards and 3 cameras



# KRATOS IU: READY TO FLY CUBESAT PLATFORM



Mexican Cubesat K'OTO using a KRATOS-IB bus



## FEATURES

- All included, Ready to fly, just add your payload
- Custom configurable to fit tight budgets
- Room for 6 standard payload boards and 3 cameras
- USB 2.0 and I2C bus as standard
- Designed for LEO missions and requirements
- LASER communications at 10Mbps available as an option
- Embedded antennas, magnetorquers, temperature and sun sensors
- Includes ICEPS all-in-one OBC, EPS, SDR radio and ADCS systems
- Battery has temperature sensors, passive heater and optional active heaters
- Automated release and deploy of panels, antennas and room to control 2 more devices
- Manufactured according to NASA and ESA space standards and materials
- Functional, performance, thermal bake out and vibration tests provided with documentation.
- Compatible and compliant with standard deployers and CubeSat Standard

## PROPERTIES

### Mass (exact mass depends on configuration):

- 1 panel : 460 g minimum
  - 2 panels: 500 g minimum
  - 3 panels: 540 g minimum
- Al T6061 structure w/ 2 tunable pushers and 1 activation switch

### Solar panels thickness:

- Folded thickness:
  - 1 panel: 2 mm
  - 2 panels: 4 mm
  - 3 panels: 6.25 mm
- Unfolded thickness: 1.5 mm

Operating Temperature: -80 to +140°C

Radiation Tolerance: 4 years minimum in LEO

### Low cost solar cells:

@BOL

Panels	Top	Bottom	Array Power
1	4.0V@0.5A	2.0V@0.5A	3.0W
2	6.0V@0.5A	4.0V@0.5A	5.0W
3	8.0V@0.5A	6.0V@0.5A	7.0W

### High power AzurSpace 3G-30:

@BOL

Panels	Top side	Bottom side	Array Power
1	9.6V@0.5A	4.8V@0.5A	7.2W
2	14.4V@0.5A	9.6V@0.5A	12W
3	19.2V@0.5A	14.4V@0.5A	16.8W

## MATERIALS

Only TML and CVCM < 1% materials used, NASA and ESA approved:

Contact sensors: Gold Deploy and Release

### Actuators:

- Deploy: Spring operated
- Release: EXA artificial muscles MDR/RIC, 50 grams max torque

Solar Cells: GaAs (High power) or mono crystalline Silicon (low cost)

Solar Cell Interconnector: Invar Silver plated

PTFE (Teflon) space grade cables, multi-strand, silver plated copper (AWG26, AWG24)





# KRATOS 1U: READY TO FLY CUBESAT PLATFORM

## PERFORMANCE (I)

### EPS:

- 100W max effective delivered power
- Payload power available from 20W (min) to 95W (max)
- 4 Power Rails: 5V@25W, 3V3@10W, 12V@50W and 1 unregulated power rail
- 1 APU connection available
- UMPPT 4-channel, 2A each, Solar power manager
- Fast 2A dual Li-poly charger onboard
- Solar array power from 3.75 W minimum to 16 W maximum
- Solar Cell Efficiency: 28% (High power) or 19% (low cost)

### Battery:

- BA03/S slim high energy density array
- 25Whr minimum, 100Whr maximum
- Embedded temperature sensor digitized by the OBC
- Standard graphene passive heater
- Optional active heater

### SDR Radio:

- Epiq Z2 Xilinx ARM9 based SDR full duplex
- SDR radio from 70MHz to 6GHz
- One Transceiver port and 2 Receive only ports

### Embedded Antennas:

- Band Range: VHF to L-band
- Monopole configuration = 2.1 dB max gain
- Dipole configuration = 3.1 dB max gain
- Extended Monopole = 2.3 dB max gain
- Lambda: from 1/4 to full wave
- Optional active S-band patch with 6.5 dBi gain, 120° aperture
- Optional active L-band patch with 5.5 dBi gain, 105° aperture

### OBC:

- Xilinx ARM9 dual core @733Mhz OBC
- Preinstalled Linux IIOS with full libraries
- 512 MB of DDR3L RAM
- 32 MB of QSPI flash storage for uboot bootloader
- 32GB to 512GB SSD radhard storage
- 24 onboard sensors, room for 32 GPIO inputs
- USB and i2C concurrent buses with room for 8 user payloads
- Linux kernel, and root file system
- 480 Mbps bus speed (USB 2.0)

### ADCS:

- 6 sun sensors input from all walls
- Integrated IMU
- Optional Novatel GPS w/antenna
- Detumbling and B dot libraries included

### Embedded Magnetorquers MT02 (4):

- Nominal Magnetic moment >0.14 Am<sup>2</sup>
- Saturation Magnetic moment >0.48 Am<sup>2</sup>
- Linearity: +/- 4% across operating design range
- Residual moment <0.0075 Am<sup>2</sup>
- Torque: 3.66 μNm @ 3.2 mTesla (1U mass)
- Angular acceleration: 1.75 Rad/sec<sup>-2</sup> (1U mass)
- B-center = 3.0 Gauss
- B-corners = 3.1 Gauss
- Typical resistance: 14.1 to 14.7 ohms @ 25°C
- Random Vibration: 16g rms

### Z Magnetorquer MT01 (1):

- Nominal Magnetic moment >0.19 Am<sup>2</sup>
- Saturation Magnetic moment >0.85 Am<sup>2</sup>
- Linearity: +/- 4% across operating design range
- Residual moment <0.0045 Am<sup>2</sup>
- Torque: 5.36 μNm @ 7.2-3 Tesla (1U mass)
- Angular acceleration: 3.2-3 Rad/sec<sup>-2</sup> (1U mass)
- B-center = 8.9 Gauss
- B-corners = 14.5 Gauss
- Typical resistance: 4.1 to 4.7 ohms @ 25°C
- Random Vibration: 16g rms

### Sun Sensors (6):

- Analog, GPIO, 5 to 16V, digitized by the ADCS
- Linear response range from 0.2V to 5V
- Working current 50 mA
- Working FOV: 65 degrees H/V

### Shielding:

- SEAM/NEMEA A-class
- Regulates temperature to a comfortable 10°C inside the spacecraft
- Stable and steady temperature through the complete thermal cycle
- Deters and attenuates Alpha and beta particles, Gamma and X-rays and L-neutrons
- Can withstand 140°C on the outside while maintaining 20°C inside



# KRATOS 1U: READY TO FLY CUBESAT PLATFORM

## PERFORMANCE (2)

### Temperature sensor(6):

- Analog, GPIO, 4 to 12V, 4 digitized by OBC
- Linear response range from 0.3V to 1.5V
- Working current: 80 mA
- Working temperature: -65 to 135C

### Actuators:

- Deploy: Spring operated
- Release: EXA MDR/RIC, 50 grams max torque artificial muscle strand

### Interfaces:

Custom choice, normally 3 Molex PicoBlade inline 4 pin connector with gold plated contacts. PTFE (Teflon) space grade cables, single strand, silver plated copper (AWG26, AWG24 and AWG30)



## TESTING and QUALITY

All platforms are provided with tests reports regarding the following tests:

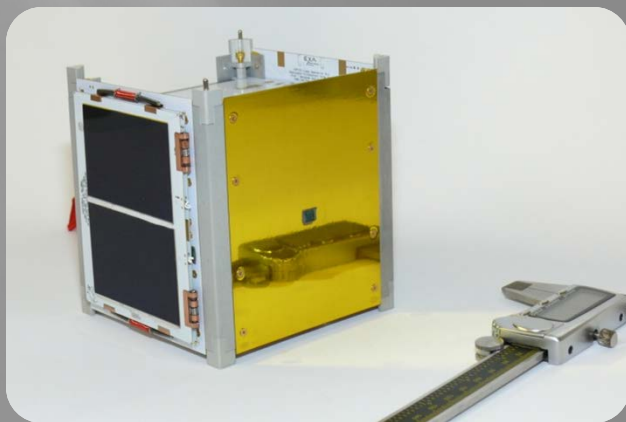
Test	QT	AT
Functional	✓	✓
Vibration		✓
Thermal Cycling		✓
Thermal Vacuum		✓
Mechanical/Dimensional compliance	✓	✓
Continuity Isolation	✓	✓
Solar cells Cracks	✓	✓
Flasher Test	✓	✓
Sensors Test	✓	✓
OBC General interoperability Test	✓	✓
USB & I2C bus test		✓
Deploy/Release Test		✓
Antennas network VSWR Test		✓
LASER emitter net power test	✓	✓
Batteries test	✓	✓
General Performance and day-in-the-life test	✓	✓

- Thermal Bake out (10E-7 mbar @ 50C for 24 hours)
- Vibration test for Dnepr, Falcon9, Soyuz, Electron and LM20

## FULL ENGINEERING SUPPORT FREE OF CHARGE

Enjoy the renowned engineering support of EXA, free of charge when you acquire a KRATOS platform, we will be with you all the way, from planning to orbit, your success is our success.

Our engineers can tailor your KRATOS to your mission needs with your customs choices. Detailed blueprints, 3D PDFs, STEP, Parasolid and SolidWorks files can be provided on demand.



## CONTACT US:

Email: [cco@exa.ec](mailto:cco@exa.ec)

Web: <http://shop.exa.ec>

Twitter: [https://twitter.com/EXA\\_ec](https://twitter.com/EXA_ec)

Facebook: <https://www.facebook.com/Agencia.Espacial.Ecuatoriana/>

LinkedIn: <https://www.linkedin.com/company/ecuadorian-space-agency>