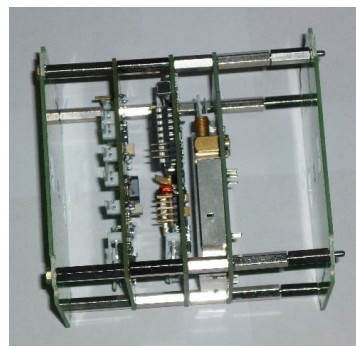




IOS CubeSat Kit Specifications and Pricing

General Description: The CubeSat Personal Satellite Kit can serve as an educational platform for use by advanced students of space science, or as a low-cost satellite option for electronics hobbyists or professional satellite builders who wish to carry out experiments, space-qualify hardware, or place applications in Low-Earth Orbit. The CubeSat can also serve as a Personal Satellite for artists, musicians, advertisers, or individuals who wish to send items into space, to transmit messages from space, or to use the CubeSat as a private mausoleum for space burial. Individual builders or teams have the option of basing their final designs on the standard components that come with the satellite kit, or of replacing all the CubeSat's standard components with their own hardware. As long as the size, weight, regulatory, and safety restrictions are adhered to, builders can equip their CubeSats with anything they wish. If needed, and for fees based on mission requirements, Interorbital Systems and its partners can offer design, development, and manufacturing services to individuals who do not possess the technical skills required to build the spacecraft.



A CubeSat kit includes the following components:

- ▼ Printed Circuit Board (PCB) Gerber Files
- ▼ PCB Mounting Hardware
- ▼ Transceiver (FCC or equivalent license required)
- ▼ A Battery Pack
- ▼ Solar Cells
- ▼ A Power Management System (PMS)
- ▼ **Arduino** Microcomputer and Development Kit
- ▼ Software
- ▼ Antennas
- ▼ CubeSat Assembly Manual (CD)

The standard Interorbital CubeSat Kit can function as a basic satellite bus or as a stand-alone satellite. If the builder decides to use the kit as a stand-alone satellite, it has many applications that can include the following:

- ▼ Automatic simple, repeating “message from orbit” transmission
- ▼ Amateur radio relay
- ▼ Space advertising

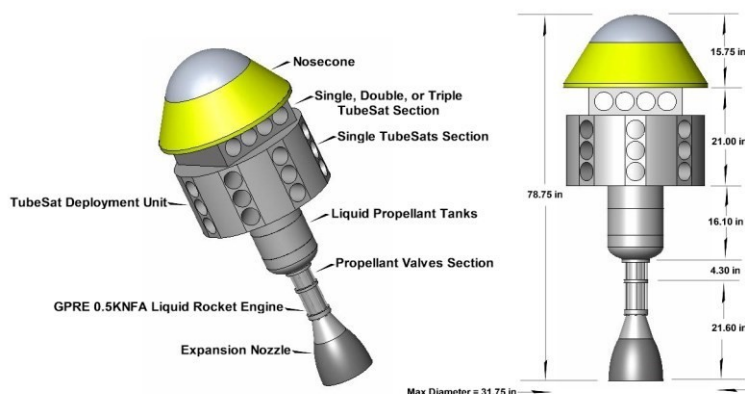
These are just a few examples. For these applications, the builder must develop software to allow the satellite to carry out the desired function.

For those who wish to include an experiment or hardware application, the possibilities can include, but are not limited to, the following:

- ▼ Earth-from-space video imaging
- ▼ Earth magnetic field measurement
- ▼ Satellite orientation detection (horizon sensor, gyros, accelerometers, etc.)
- ▼ Satellite attitude-control system
- ▼ Orbital environment measurements (temperature, pressure, radiation, etc.)
- ▼ On-orbit hardware and software component testing (microprocessors, etc.)
- ▼ Tracking migratory animals from orbit
- ▼ Testing satellite stabilization methods
- ▼ Biological experimentation

Once again, these are just a few examples and they all require additional hardware not included in the basic kit. For these functions, the builders must assemble and test their own hardware and integrate it into their satellite.

Builder Experience: We recommend that a CubeSat purchaser have experience in electronic device assembly and in programming microcontrollers. The builder should also have experience programming with the BASIC or other computer programming language. Of course, if a builder does not have the recommended experience, he or she can use the CubeSat as a learning device. Developing and constructing a CubeSat is also an ideal team-building project.



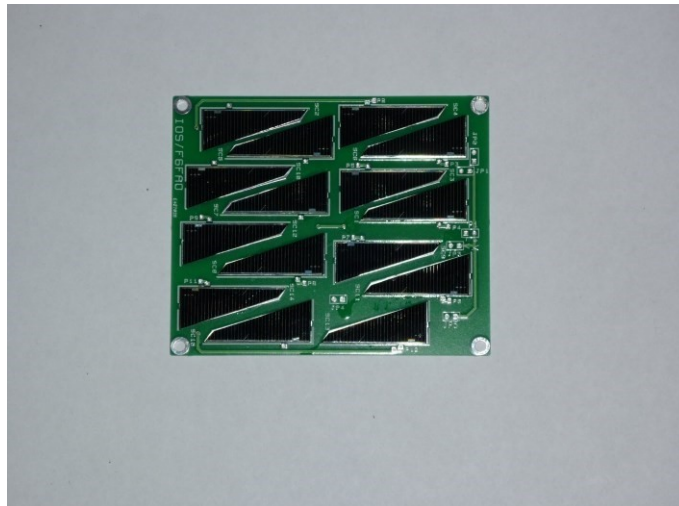
CubeSat Design: CubeSats are cubic structures with an internal component rack assembled from stand-offs and printed circuit boards (PCBs). The exterior of the CubeSat is assembled from an aluminum chassis and solar cell circuit boards. The sats are designed to be ejected from their own dedicated ejection cylinders. For each launch, there are multiple ejection cylinders which are arranged in a CubeSat/TubeSat Deployment Unit.

The CubeSat structure includes external Teflon angle guide-bearings that center the CubeSat in its ejection cylinder, and facilitate the satellite's deployment. This arrangement allows the CubeSat to be smoothly spring-deployed from its ejection cylinder with minimal friction.

The CubeSat ejection cylinders have an inside diameter of 9.91 cm (3.9 in). A solenoid actuator hooked through a nylon line holds the CubeSat under tension until the spacecraft is ready for deployment. The solenoid actuator is extended to release the CubeSat from its ejection cylinder.

The solar cells are arranged in strips around the outside of the CubeSat. Solar panel deployment is not required, unless desired by the builder. The standard CubeSat antennae are made of spring-steel and slip into the Ejection Cylinder, allowing automatic antennae deployment upon release.

The CubeSat components are attached to printed circuit boards. The printed circuit boards (PCBs) are separated by groups of stand-offs. The CubeSat's exterior structure consists of high-efficiency solar cells mounted on PCBs.



Although the CubeSat kit includes all the basic components required to build a low-cost satellite bus or a fully functioning satellite, it is the task of the CubeSat builder to integrate the components into the satellite envelope. This includes PCB fabrication, soldering (including reflow), drilling holes, mounting the hardware on PCBs, wiring, programming, testing, and everything else required to assemble a working satellite. The builder must also develop his or her CubeSat's experiment or application software.

The basic components are Commercial-Off-The-Shelf (COTS).

COTS Component List

1) Transceiver

Builders must apply to the FCC or non-US equivalent for a transmit-and-receive frequency allocation for space-based operations. For the amateur radio band, you should apply for a frequency between 435 MHz and 438 MHz. To use these frequencies, you or a team member must also possess an amateur radio license.

Radiometrix Transceiver Option

Transceiver: Radiometrix TR2M

<http://www.radiometrix.com/files/additional/tr2m.pdf>

In addition to the Transceiver, you will receive the following amplifier. This will also plug into your transceiver PCB

Amplifier: Radiometrix AFS2

<http://www.radiometrix.com/files/additional/afs2.pdf>

Output: 100mW or 500mW (using AFS2 amplifier)

Frequency: 435 - 438 MHz in 5MHz increments

The Radiometrix transceiver is programmable over a short frequency range (See Radiometrix web site). Since this transceiver operates in the amateur radio band, an amateur radio license and frequency allocation/experimental permit is required (responsibility of CubeSat builder) to legally use the transceiver. The advantage of the amateur radio band is that anyone in the world with an amateur radio receiver (even a hand-held receiver with the proper antenna) can receive transmissions from the satellite. Builders will need to have a hand-held or other amateur radio to communicate with the satellite transceiver during development.

The amateur radio band cannot be used for commercial communications. Information about how to obtain the required amateur band frequency allocations for satellites can be found at:

http://www.interorbital.com/Downloads/IARUSATSPEC_REV15.6.pdf

Builder Option

The builder also has the option of replacing the standard transceiver with a transceiver of his or her choice. Any transceiver must comply with international licensing and frequency band requirements.

Batteries

Li-Ion 3.7V 2600 mAh Rechargeable Battery Module (COTS)

Power Management Board

In-house design

The power management system uses the output of the solar cell complex to keep the on-board batteries charged.

Microcomputer

Arduino Mini

It is important that the satellite control software be designed to turn the transceiver on only when transmitting or receiving, and to cease transmission or reception when the battery power is dangerously low, to avoid battery damage

Solar Cells

Spectrolab Triangular Advanced Solar Cells (TASC)

Efficiency: 27%

http://www.spectrolab.com/DataSheets/PV/PV_NM_TASC_ITJ.pdf

The solar cells are arranged around the CubeSat tube on panels. The number of individual triangular cells amounts to sixty (60) per CubeSat. Each triangle can generate an output of thirty-one (31) mA. The total output generated by the cells at any one time on orbit will depend on the satellite's orientation. The builder has the option of integrating additional solar cells into his or her CubeSat. Extra solar cells are available from IOS. See price list below.

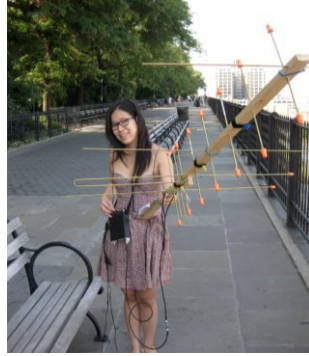
Assembling a CubeSat: The IOS CubeSat was designed to give the builder maximum design flexibility. The arrangement of its components can be modified according to the builder's plan. In addition, the builder has the option of replacing the standard components with his or her own component choices. A builder can also opt to remove all the components from the satellite and fill the space with mementos or even cremains (ashes for burial in space). CubeSats are fully customizable.

The basic components are enough to build a satellite that can carry out simple operations such as transmitting a message from space or relaying text and messages from a ground station to the satellite for re-transmission. These applications will require the builder to develop software to carry out these functions.

Parts Replacements: If the builder should accidentally damage a CubeSat component, Interorbital will replace the part at cost + shipping. CubeSat builders also have the option of buying a backup CubeSat kit at a reasonable cost.

Payload Environment: CubeSats and the CubeSat Ejection Cylinders are not sealed and will always maintain internal pressure at ambient. The maximum payload G-force is 6 Gs during the Satellite Module engine burn. Since both the NEPTUNE 5 (N5) and NEPTUNE 9 (N9) rockets have a low thrust-to-weight ratio, the vibration, shock, and acoustic environments are relatively benign. Vibration, shock, and acoustic data will be made available shortly.

Orbital Environment: CubeSats are deployed in a circular 310-km altitude polar orbit. The polar orbit allows CubeSat communications from any point on the planet with daily minimum line-of-sight distances. When a small satellite is deployed, it will always to some degree of tumble or spin. It is possible to eliminate the tumbling by using a static stabilization system. The simplest method is to attach magnets to the outside of the CubeSat to allow the spacecraft to orient itself with Earth's magnetic field. Dedicated launches to orbits and altitudes other than the standard IOS small sat orbit are available at additional cost. Please contact Interorbital with your mission requirements for a price quotation.



Communication with the Orbiting Satellite: Once a CubeSat is on-orbit, the builder will be able to precisely calculate the position of the satellite. With the CubeSat transceiver output set to at least 500 mW and the satellite directly overhead, communication can be achieved with a simple hand-held Amateur Radio receiver (not included with kit) if the satellite is transmitting on an amateur radio band. In this case, a simple Yagi antenna is required (see picture above).

More powerful ground stations allow communications at lower angles. Interorbital is currently helping to coordinate a global network of receivers that will eventually be capable of receiving satellite transmissions for posting on a central website. In future, Interorbital will make a portable ground station kit available.

Shipping to Interorbital Systems before Launch: CubeSats should be completed and delivered to IOS in Mojave at least 2 weeks before the scheduled launch date and delivered along with all testing, inspection, integration, and regulatory paperwork to Interorbital Systems. If complete and proper documentation accompanies the satellite, the spacecraft will be integrated into the N5 or N9 rocket for launch.

CubeSat Dimensions: Maximum Dimensions and Mass Requirements

CubeSat

Maximum Dimensions: 4.0 in (101.75 mm) square (varies slightly) with 7 mm rail extensions

Maximum Length: 4.5 in (114 mm)

Maximum Weight: 1.0 kg (2.205 lb) or 1.33 kg (2.93 lb) (this depends on your order---if you exceed the weight maximum there will be additional charges for that extra weight)

Ejection Cylinder

Inside Diameter: 5.9 in (149.86 mm)

Support: CubeSat support is also available at the TubeSat Builders' Forum, which is open to satellite kit buyers. Forum access comes with purchase of a kit.

Special Note for CubeSat Kit and Launch Package Buyers: CubeSats are available in the old standard of 1kg or the new standard of 1.33kg. Please specify your choice when ordering. See price list for details.

Version 1.6.12

All Specifications and Pricing Subject to Change

Price List

All TubeSat kit and CubeSat kit sales with full payment include the price of a launch to a 310-km circular polar orbit.

Academic / Non-profit/ Small Business Research Pricing:

| | |
|---|-------------|
| TubeSat Kit with launch: | \$8,000.00 |
| TubeSat launch only: | \$8,000.00 |
| CubeSat kit (max.1kg; old standard) with launch: | \$15,500.00 |
| CubeSat kit (max.1.33kg; new standard) with launch: | \$19,625.00 |
| CubeSat (max.1.33kg) launch only: | \$16,625.00 |
| CubeSat (max.1 kg) launch only: | \$12,500.00 |

Available only to builders who have already purchased a TubeSat/launch or CubeSat/launch:

| | |
|--------------------------------|------------|
| CubeSat Backup Kit (no launch) | \$3,450.00 |
| TubeSat Backup Kit (no launch) | \$2,075.00 |

Corporate, Military, Government Pricing:

Academic Pricing x 2

Example: TubeSat Kit with Launch for Corporate/Government client: $\$8000 \times 2 = \$16,000.00$
 Example: CubeSat Kit with launch for Corporate/Government client: $\$15,500 \times 2 = \$31,000.00$

Payload space on low-altitude test launches (25,000-50,000 ft): \$2,500/kg and up, depending upon customer requirements (recovery, deployment video, etc.) and payload mass, volume, and footprint; 2016 space-altitude suborbital launch: \$5,000 (academic) and up per kg. Base price for dedicated launch (purchase of all payload space): suborbital space-altitude launch: \$350,000/100kg; base price for orbital launch: \$1 million/30kg). Please contact IOS for details.

Shipping, insurance, and handling costs for non-US orders (US Postal Service): \$150.00 and up

Import/Export License Service Fee \$500.00 (\$250 if for import only)

**All sales subject to 8.50% sales tax, except for tax-exempt entities All
 Prices are Subject to Change**

Contact Interorbital Systems at 661.965.0771 or ios@interorbital.com
 Website: www.interorbital.com