1U FastBus CubeSat Platform

Ready to Fly Satellite Bus

Interface Control Document (ICD)

NearSpace Launch, Inc.

8702 E. 825 S.

Upland, Indiana 46989

Jeff Dailey, Chief Engineer: (260) 241-0409, jfdailey@nearspacelaunch.com

Matt Orvis, Project Engineer: (808) 990-4488, mattorvis@nearspacelaunch.com

www.nearspacelaunch.com

This document describes the functional and mechanical characteristics of the 1U FastBus CubeSat Platform. This interface control document is intended to provide the payload integrator with the necessary technical information to integrate their payload into the FastBus.

For electrical interfacing, see the EPS ICD. For communication interfacing, see the appropriate Comm System ICD (EyeStar-S3 or EyeStar-D2).

Document Classification	
X	NSL Proprietary

1. Operational Description

The FastBus is designed to provide all the necessary architecture to support the launch and operation of an appropriate payload. The main included subsystems are described below:

- Structure
    - A unibody frame made of hard anodized Al 6061-T6 is precise and rigid to maintain tolerance during launch conditions, and provides good EMI radiation and energetic particle shielding and thermal shorting.
    - Two access panels along the +/-X faces are present for ease of assembly and testing.
    - The frame and access panels are easy to modify for custom mounts, antennas, connectors, and view ports.
    - Slide in Optical Bench is available for easy assembly and testing of subsystems.
- Electrical Power System (EPS)
    - Provides switched power outputs to the payload of 3.3 and 5 V, as well as an unregulated battery line for higher currents.
    - Receives power from solar arrays and charges the integrated battery stack.
- Flight Processor:
    - Controls and coordinates other FastBus subsystems.
    - Interfaces directly to the processor via a serial link, using TTL RS232 protocol. There are 8 available digital/analog inputs to be sampled at set time periods.
    - Depending on complexity, the FastBus processor can be used to implement the payload Con Ops.
- Communications
    - Includes a Globalstar connected EyeStar-S3 Simplex. This provides a live, global downlink with 24/7 connectivity and a latency of one second.
        - It is able to send small packets of data from the user to the LEO GlobalStar satellite network. The data is received by a ground station gateway, forwarded to the NearSpace Launch server, and delivered to the end user for processing.
        - Able to maintain 95% throughput, even while tumbling.
        - Two types of data packets are sent from the module: payload data and beacon data. Beacon data is a set of internal diagnostic, digital, and analog inputs that are sent at a set interval for health and safety information. Additional packet types would depend on the desired configuration, and could include GPS packets, imaging packets, and science data.
    - A Globalstar connected EyeStar-D2 Duplex is also available.
        - Provides a two-way, live link that enables higher speed data downlinks as well as commanding.
        - Requires more power and stabilized pointing.
    - Other 3rd party communication systems can easily be specified an integrated, if higher data rates are required.
- Solar Arrays
    - Three fixed 1U arrays of 2W each are included in the baseline for a total of 6W.

- Optional additional arrays include a 4th 1U face, +/-Z face arrays, and deployable arrays, for a total of up to 26W.

- Attitude Determination and Control System (ADCS)
  - Active and passive magetic systems
    - High permeability metal uses hysteresis effect to detumble satellite.
    - Magnetorquers also detumble satellite.
  - Any 3rd party ADCS system can be specified and included for higher precision pointing.

1.1 EPS and Simplex Block Diagram

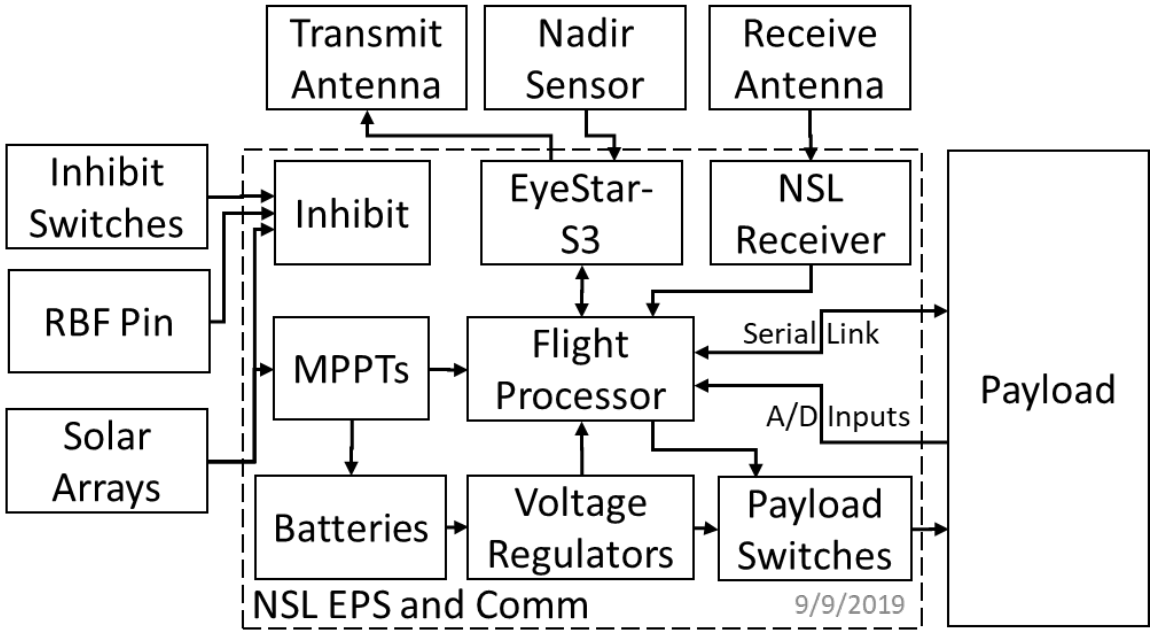

Figure 1 NSL EPS and Simplex "All-in-one" system block diagram. Note the dotted line box shows the EPS and Simplex unit hardware, while the boxes above that show included peripheral hardware.

2. System Layout

The NSL FastBus is divided into 2 sections, the NSL Bus and Payload Volume. The NSL Bus is located in the -Z end of the CubeSat, using about 0.5U of space (baseline). Adding additional options, such as GPS, extra batteries, EyeStar-D2 Duplex, etc., will increase the NSL Bus volume. All space not used by the NSL Bus is available as part of the Payload Volume. Exceptions to this would be cabling required for NSL parts mounted on the +Z face. An optical bench can be provided on request to allow all payload systems to be mounted on a single plate. This assembly can then be integrated as a single unit.

While the Z axis is pointing toward the optional solar deployment hinges, this does not necessarily reflect the RAM axis during flight, and is configured this way for CubeSat launcher requirements only.

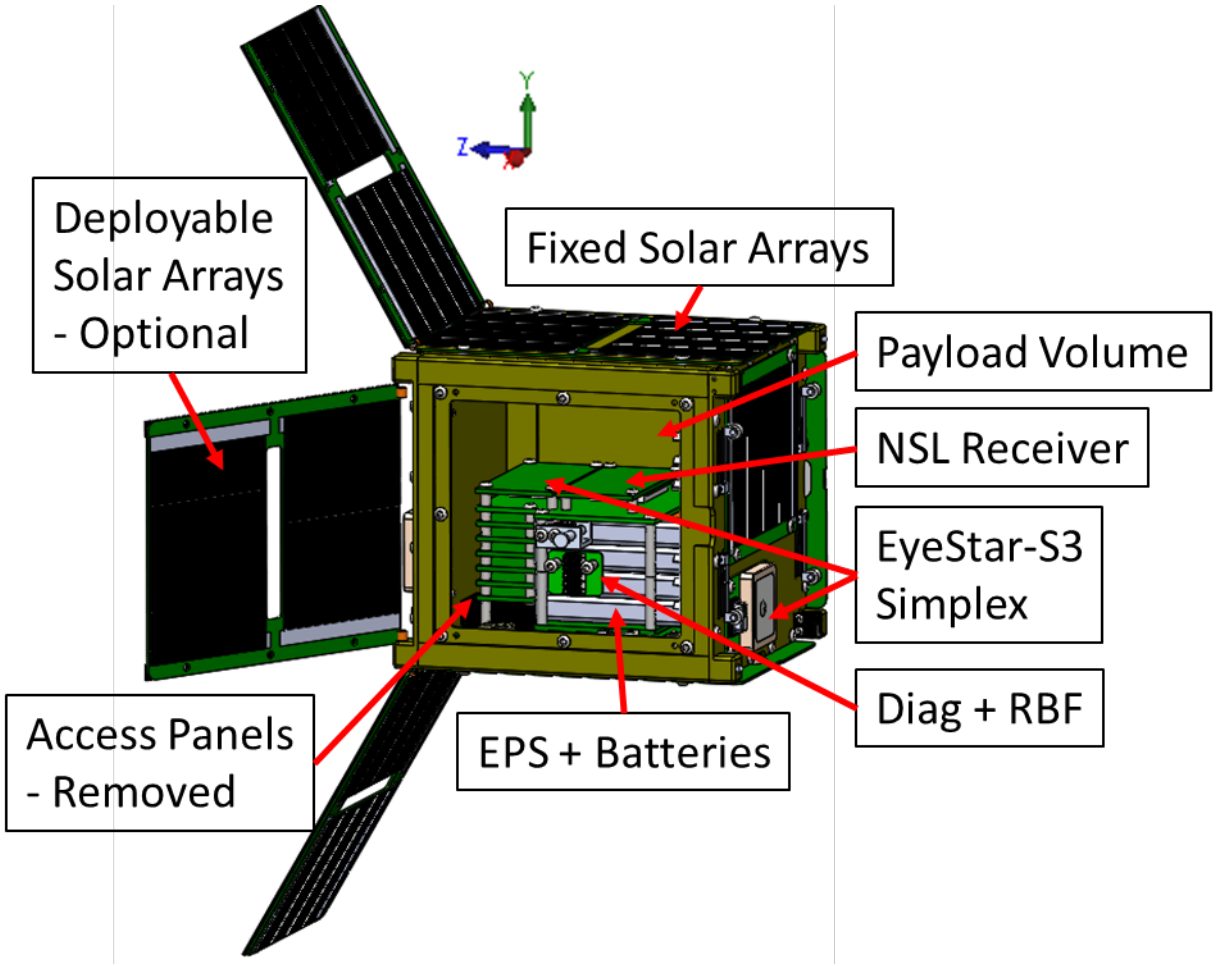

Figure 2 System Level Diagram of 1U FastBus with callouts. Note the optional systems. The NSL subsystems use about 0.5U of inner space, leaving about 0.5U of space for the Payload Volume.

3. Mechanical Layout

The 1U FastBus adheres to the strictest CubeSat launcher requirements, allowing it to be compatible with all CubeSat launchers currently on the market. Additional space outside of the 100 x 100 mm for sensors or deployable solar arrays will be dependent on the launcher. Consult with NSL when considering external components.

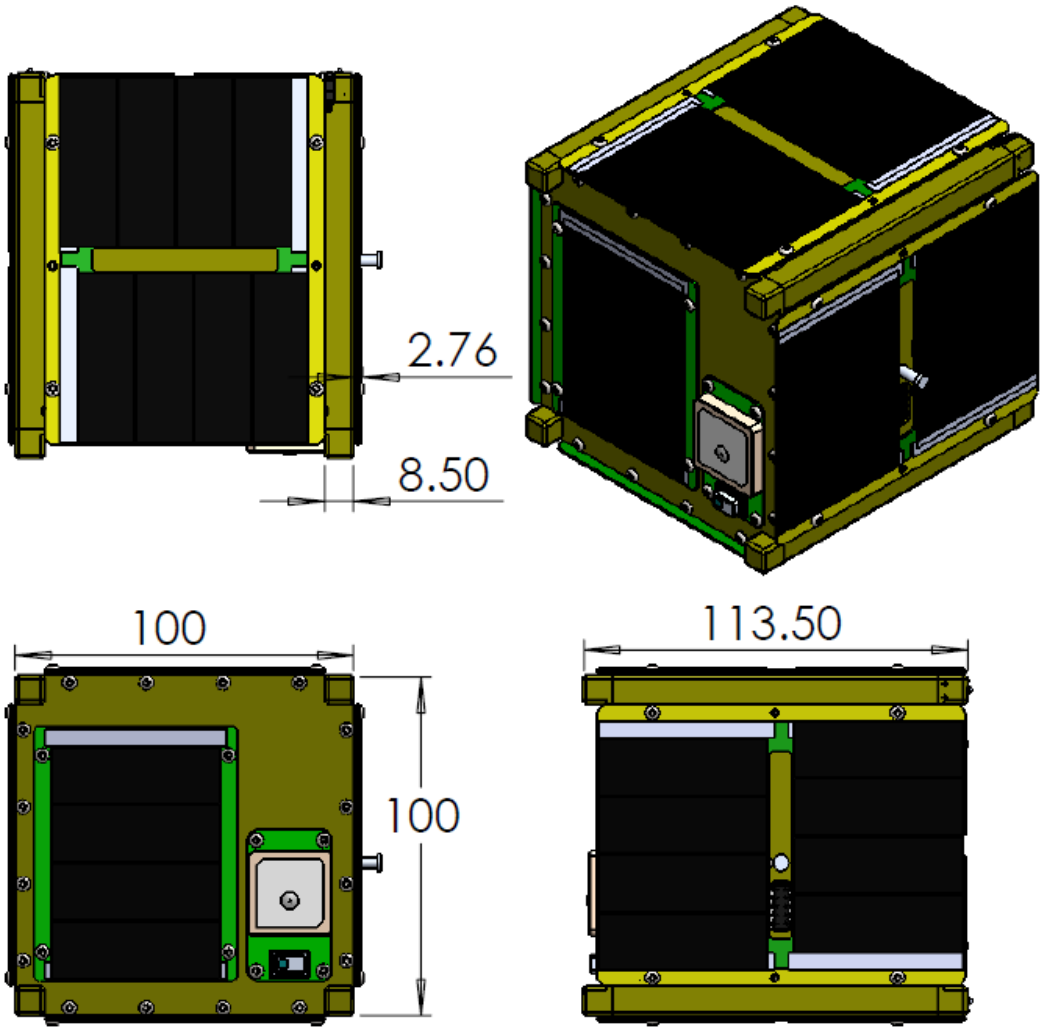

Figure 3 External View of 1U FastBus. Dimensions in mm. Note adherence to 1U CubeSat standards, as well additional available volume outside of the rail dimensions. The optional Black Box would mount externally, replacing one of the +/-X 1U solar panels.

3.1 Payload Volume

The payload has a maximum cross-sectional area of 92 x 92 mm, constrained by the internal walls of the aluminum frame. The frame can easily be modified and cut in order to allow larger components to fit. The maximum payload height is 39 mm. This will be heavily dependent on the selected configuration, and which options are included in the NSL Bus. Customized CAD models of the selected configuration are available on request.

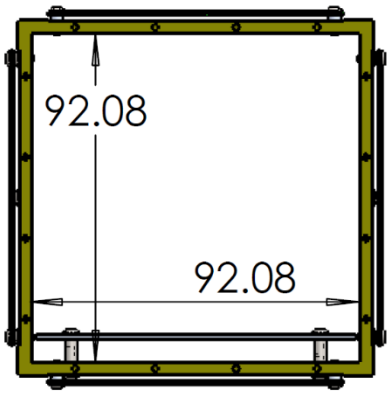

Figure 4 Inner structural dimensions of X and Y axes. PC104 type electronics are able to fit. Note the optional optical bench to assist in easy integration and testing.

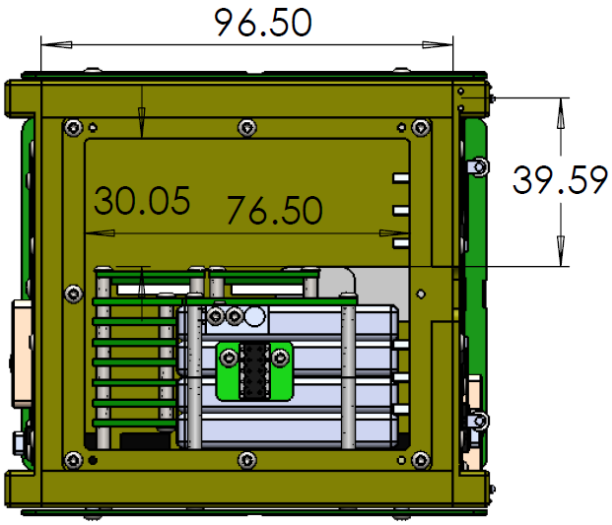

Figure 5 Inner dimensions of payload volume along Z axis. Also shown are the dimensions of each access panel on +/-X faces.

4. Assembly

The integration and assembly of the payload and NSL FastBus is made much simpler by use of the optical bench and available access panels. By mounting and integrating all systems possible to the optical bench, it may then be slid in from the +Z end and integrated as a single unit. Then, any additional connections or adjustments may be completed through use of the access panels.

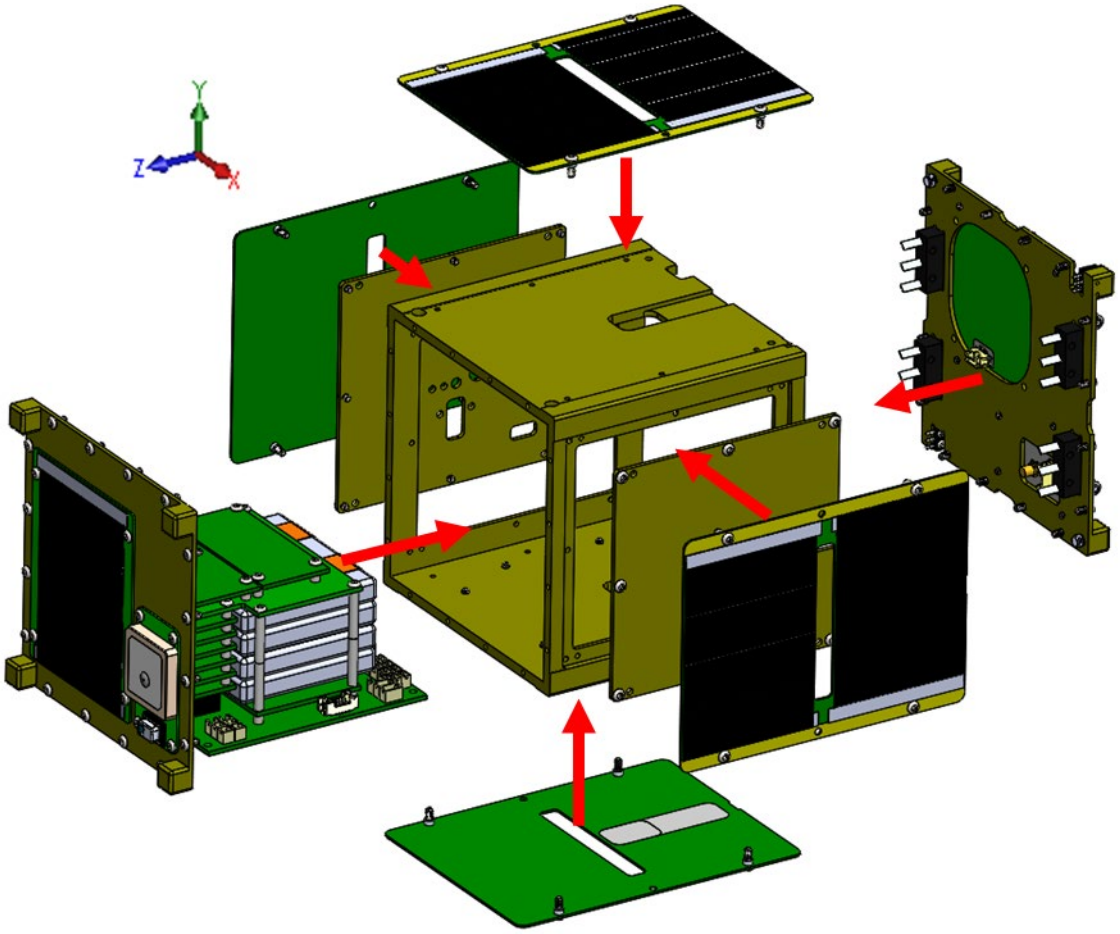

Figure 6 General overview of assembly of 1U FastBus. The optical bench and payload can slide in from the Z axis before being integrated to the NSL Bus Electronics stack. Note that this shows the optional 4th side mounted solar array.

5. Integrated Options

5.1 Communications

5.1.1 EyeStar-D2 Duplex

NSL's Globalstar connected Duplex has similar advantages as the Simplex, it offers live streaming data, with 24/7 connectivity to your satellite. It has a two-way link, at 700 bytes/s.

5.1.2 3rd Party Communication System

If higher data rates are required, any 3rd party communication system can be integrated into the FastBus on request.

5.2 Extra Solar

5.2.1 Fixed Body Solar Arrays

3 fixed body side (X/Y) solar arrays are included in the FastBus. 1 additional side solar panel may be added. +/- Z arrays may also be mounted to the endplates, if that surface area is note bring used by antennas.

5.2.2 Deployable Solar Arrays

Full length deployable solar arrays are available, with elastic unfolding and a rigid hinge. Burn wires are included with this option to restrain and deploy these solar panels.

5.3 Extra Batteries

5.3.1 2x1 Stack

Add an extra 37 Whrs with 2 cells stacked.

5.3.2 1x2 Flatpack

Add an extra 37 Whrs with 2 cells side by side.

5.4 Additional ADCS

Active and passive magnetic detumble is included. If any pointing is required, any specified 3rd party ADCS may be included. A single axis reaction wheel with magnetic nadir pointing (MAI-25) is recommended.

5.5 Propulsion

Include any 3rd party propulsion system. Consult with NSL about specifications.

5.6 GPS

While the FastBus does not include a GPS, any GPS can be integrated into the NSL FastBus . We recommend a NovAtel GPS, which would transmit data with the following specs:

Model: NovAtel OEM719-GSN-LNN-TBN-H

GPS Data: Best Position – Latititude, Longitude, Altitude

5.7 Sensors

A sensor suite may be included with a wide range of sensors. These can include: plasma probe, particle detectors (for dose and radiation belt monitoring), IR, micro-meteor, and others.

6. FastBus Specifications

Specification	Symbol	Minimum	Nominal	Maximum	Units
EPS Power					
Switched 3.3 V (3x)	3.3_V	3.2	3.3	3.4	V
- Total 3.3 V lines current	3.3_I			2	A
Switched 5.0 V (3x)	5.0_V	4.9	5.0	5.1	V
- Total 5.0 V lines current	5.0_I			2	A
Battery Line	BUS+_V	6.0		7.2	V
	BUS+_I			6	A
Battery + Solar Power					
Battery Capacity	B_Cap	18	37	111	Whrs
Solar Power/side panel	SP_s			2	W
Solar Power/end panel	SP_e			1	W
Number of side panels		0	3	4	Panels
Number of end panels		0	0	2	Panels
Body Solar Power (total)	SP_tot	0	6	10	W
Deployable Solar Power	DP_tot			16	W
Simplex RF Characteristics					
Frequency range	f		1616.25		MHz
Output power	P_TX	+16	+18	+20	dBm
Bandwidth			2.5		MHz
Modulation			BPSK		
Duplex RF Characteristics					
Frequency range – Tx	f_TX	1610		1625.5	MHz
Frequency range – Rx	f_RX	2483.5		2500	MHz
Output power	P_TX		1.972		W
Modulation			CDMA		MHz
Simplex Antenna					
Polarization			LHCP		
Efficiency			80		%
Realized gain			5		dBic
Bandwidth (3 dB)	Both axes		100		Degree
VSWR			1.3:1		

Physical					
Outer Dimensions	LxWxH	100	100	113.5	mm
Payload Dimensions	LxWxH	92	96	39	mm
NSL Bus Mass	m_BUS		0.82		Kg
Payload Mass	m_payload			1.1	Kg
Operating Temperature		-35		60	^{o}C

7. Customer Specific Configuration

Communicate with NSL regarding the specific configuration of your FastBus unit.

Configurable	Spec	Default	Units
TX Inhibit Timer	0 – 45	0	Minutes
Beacon Type	GPS, Analog, H&S, etc	H&S	Packet
Beacon Period	0.25 – 50	15	Minutes