GPS BOARD AND ANTENNA SPECIFICATIONS

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1. Scope: The science mission of the Cubesat is to obtain a profile of ionosphere plasma densities. One of the techniques will be GPS scintillation, where GPS signal strength at a point at two different times is compared. To achieve this, the satellite will be required to fly a GPS receiver and antenna. For simplification of systems, a two antenna configuration will be implemented.

1.1 General. This specification establishes the design, construction, performance, development, and test requirements for the Cubesat GPS receiver, herein referred to as the GPS board. This specification establishes the design, construction, performance, development, and test requirements for the Cubesat GPS antenna, herein referred to as antenna.

1.2 The receiver is required to sample at 72Hz in a space environment. With no Commercial Off The Shelf (COTS) receivers that will do this, a GPS receiver board will either need to be modified or constructed.

The constructed GPS board must be compatible with the antenna.

2. APPLICABLE DOCUMENTS

The following documents of the exact issue shown shall form part of this specificaion to the extent specified herein. In the event of conflict between the requirements of this specification and any referenced document the order of precedence shall be 1. The contract, 2. This specification, 3. Referenced documents.

2.1 Government Documents.

TBD

2.2 Industry Documents.

Cornell GPS Cougar Specifications (TBD)

One Stop Satellite Solutions, Launch Services Specifications

Toko America DAX Dielectric Patch Antenna Specification (TBD)

2.3 Project Documents.

UW Cube Sat Attitude Dynamics Specifications

UW Cube Sat Structures Specifications

UW Cube Sat Systems Specifications

3. REQUIREMENTS

3.1 Item definition. The GPS board and Antenna for the CubeSat are described by the following:

The GPS board is the device that receives a signal from the antenna, conditions and processes the signal into amplitude and location, and sends the data, with a time stamp, to the Command and Data Handling unit.

The Antenna receives the GPS signal and transmits it to the GPS board

3.2 Illustrations *or* Functional Block Diagram. TBD

The entire GPS system will be wired in the form of Figure 1.

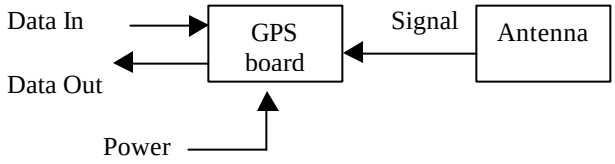

Figure 1: Block Diagram requirements

Data In is the signal from Command and Data Handling to turn on or turn off.

Data Out is the transmitted data (constant??) to Command and Data Handling in the form of Amplitude, Location, and Time.

Signal is the non-amplified direct signal from the antenna

Power is the 5 Volts from the power system

3.1.2 Interface Definition

The GPS board must conform to the input system of required by a Tattle Tale 8 microprocessor or to the RS 232 communication protocol.

3.1.2.1. Physical (TBD)

The first constraint placed on a GPS board is that it must fit into a 10cm by 10cm by 10cm cube. More precisely, the board must fit in an box 9cm by 9cm by 2.1 cm high. The board will be mounted internally by four screws onto the supporting structure.

The Antenna must be able to be mounted on the surface of the spacecraft with epoxy

3.1.2.2. Electrical

GPS The GPS board must operate on a 5 Volt DC Power supply

The entire GPS system must operate on a Maximum of 2 Watts

Antenna (none)

3.1.2.3. Functional *or* Informational

GPS The GPS board must connect to the antenna with a coaxial wire

If signal amplification is necessary, it will be a function of the GPS board

Antenna The antenna must connect to the GPS board with a coaxial wire

3.1.2.4. Characteristics

3.1.2.5. Performance Characteristics

For the science mission, the board shall

1) Sample a single GPS amplitude at 72Hz with 10 bit accuracy + 1 bit stop (11)

2) Sample a GPS location at 1/60 Hz (one minute) with a 32 bit accuracy + 1 bit stop (33)

3) Sample a GPS time stamp at 1/60 Hz (one minute) with a 10 bit accuracy + 1 bit stop (11)

4) For data handling, all data will be followed by a 1 bit stop

5) Data stream will be in multiplies of 11 bits

3.2.2 Physical characteristics.

The GPS board must fit in an box 9cm by 9cm by 2.1 cm high. The CG of the board must be at the center of the board, +/- (TBD).The weight of the board itself must be 80 grams or less.

The Antenna must be a patch antenna able to be mounted on the surface of the spacecraft. The weight must be 10 grams or less, covering an area less than 20mm by 20mm. The CG of the antenna must be at the center of the antenna +/- TBD.

There will be two GPS antenna, as dictated by the UW Cube Sat Attitude Dynamics Specifications.

The weight of the GPS board, antenna, and supporting components must not weigh more than 100 grams, as dictated by the UW Cube Sat Systems Specifications.

3.2.3 Reliability TBD

3.2.4 Maintainability.

Once installed, programmed and sealed into the Cubesat, the GPS board must perform correctly without maintenance. Once installed on the surface and to the GPS board, the antenna must perform correctly without maintenance.

3.2.5 Environments.

3.2.5.1 Natural Environments. Both receiver and antenna shall meet the requirements of this specification during and after exposure to any combination of any of the following natural environments. The items may be packaged to precluded exposure to any environments that would control the design. Typical environments include (but are not limited to):

- Must be space rated or tested to comparable conditions to confirm operation
- -30C to +70C operating temperature
- -40C to +85C storage temperature
- GPS Receiver must be able to track position while travelling at greater than 7000 m/s
- GPS Receiver must be able to track position at altitudes of 300kM or greater
- GPS Antenna must be pointed to provide the amplitude readings with accuracy of (TBD)

3.2.5.2 Induced Environments. The item shall meet the requirements of this specification during and after exposure to any logical combination of the following natural environments.

- Must withstand launch axial forces provided by the UW Cube Sat structural specifications
- Must withstand launch vibration forces provided by the UW Cube Sat structural specifications
- Further testing of components to confirm space reliability is required

3.2.x Other Possibilities include Transportability, Human Factors,

3.3 Design and construction.

See Cornell Cougar specifications

3.3.1 Parts, materials, and processes. TBD

3.3.1.1 Corrosion prevention and control. TBD

3.3.1.2 Non-destructive inspection. TBD

3.3.1.3 Special Metal Forming. TBD

3.3.1.4 Metal Joining. TBD

3.3.1.5 Fasteners. TBD

3.3.1.6 Pneumatic, hydraulic and fluid parts. TBD

3.3.1.7 Wiring, Cabling, and Connectors.

The Antenna requires a TBD gauge coaxial line

The Command and Data Handling requires two TBD gauge lines connected to Data In and Data Out

The Power system wiring TBD

// End of Changes// See Appendix at end//

3.3.1.8 Plastics and polymers. TBD

3.3.1.9 Ceramics. TBD

3.3.1.10 Composites. TBD

3.3.1.11 Lubricants. TBD

3.3.1.12 Electronic parts and Printed Wire Boards. TBD

3.3.2 Cleanliness. TBD

3.3.3 Electromagnetic interference (EMI). TBD

3.3.4 Outgasing and venting (TBD)

3.3.5 Corona. Electronic circuits are subject to damage from glow discharge called corona in vacuum. Special requirements may be imposed for trace and wire separation distances at certain voltages.

3.3.6 Nameplates and Product marking.

- Manufacturer's part number
- Approved nomenclature (name and type if any)
- Controlling specification number
- Manufacturer's name and trademark
- Serial number

3.3.7 Workmanship. The unit shall be fabricated and finished in a thoroughly workmanlike manner. Particular attention shall be given to freedom from blemishes, defects, burrs, and sharp edges; accuracy of dimensions; radii of fillets; marking of parts; thoroughness of cleaning; quality of brazing, welding, riveting, painting, and wiring; alignment of parts; and tightness and torquing of fasteners.

Interchangeability and replaceability

3.3.8 Safety

3.3.8.1 Hazardous materials

3.3.8.2 Pressurized systems

3.3.9 Human performance/human engineering

3.3.10 Structural Integrity

4. QUALITY ASSURANCE PROVISIONS

4.1 General

4.2 Quality conformance verification

a. Quality conformance methods

b. Demonstration

c. Analysis

d. Test

4.2.1 Test category definitions.

a. Development Tests

b. Acceptance Tests

c. Qualification Tests

4.2.2 Test type.

a. Performance test

b. Functional test

c. Environmental test

Appendix A: Candidates for components

For the GPS board:

The Cornell Cougar is an option for the board. Some of the specifications include:

Weight = 39 grams

Dimensions = 9.525cm by 5cm by 1.7 cm

Average Power 300mA at 5V +/- .25 Volts

Electrical Interface: 0/5 Volt TTL level RF connector

Data Interface: TBD

Structural Interface: 4 holes, .373cm in diameter

Spaced in rectangle 8.86 by 4.32 cm apart

Thermal Environment: TBD

Flight experience on Sounding rockets

Sampling Rate: TBD (currently 50Hz)

The unit meets the specifications except for dimension. The 9.525 length is too long. An option is to adjust the internal cube configuration to accommodate the board. The Cougar does require a signal amplification of 20 to 35dB from the antenna. The antenna does not amplify signals so this will have to be done on a board external from the antenna. This will add weight, but seeing as the GPS board is specified to have 80 grams, this allows at least 40 grams to work with. A simple amplifier, consisting of an op-amp, would only weigh a few grams. In addition, the power aspect will have to be looked at, but the half watt clearance between the appropriated 2 Watts and the 1.5 Watts the Cougar draws should be adequate.

For the antenna:

The Toko DAX Dielectric Patch Antenna is an option. Its size is 18mm*18mm*4.5mm. Given the small size, it should weigh less than the specified 10 grams. However, the thermal conditions, signal loss, and space worthiness must be tested. The specifications are referenced in the

Toko America DAX Dielectric Patch Antenna Specification (TBD)

Figure 2: Toko GPS patch antenna