This document explains the function of the -Z Panel, its schematic level design, its board level design, and its functional testing

-Z Panel

High Gain Communication Antenna

Revision: 1.0.5

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1   Introduction

This document explains how the -Z Panel will fulfill the following Functions and conform to the following Requirements. This document refers to the -Z Panel version 1.0.

1.1   Functions

The -Z Panel is responsible for the following:

- Provide the high gain communication antenna
- Provide a Sun sensor for the ADCS

1.2   Requirements

The system requirements and -Z panel requirements can be found here.

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2　Detailed Description

This section references the -Z panel schematic. Page numbers will be listed and may have coordinates listed (number and letter combination found around the frame).

2.1　Functional Block Diagram

The block diagram can be found on the first page of the schematic.

2.1.1　High Gain 230mm Antenna

The high gain antenna is responsible for maintaining a good downlink for communication and is controlled by the Comms subsystem.

2.1.2　Antenna Deploy Release

The antenna deploy release is responsible for deployment of the high gain antenna and is controlled by the EPS.

2.1.3　Photodiode

The photodiode is used as a sun sensor for the ADCS to determine the location of the sun.

2.1.4　Analog-to-Digital Converter

The analog to digital converter (ADC) converts the photodiode analog signal to a digital signal for the ADCS .

2.2　Schematic

2.2.1　Isolated Grounds

Power ground (PGND) is connected to the EPS circuits for the Antenna Deploy Release. Digital ground (DGND) connects to the ADCS connector as the reference for its I²C bus. Analog ground (AGND) connects to analog monitoring circuits including the ADCs, their voltage reference, and the thermistors. Analog ground is connected to digital ground using a 0Ω resistor rated up to $2A$, the expected current is less than $50mA$. Chassis ground (CHASSIS) is connected to the mechanical features including bolt holes. RF Ground (RFGND) is connected to the Comms' coax for the High Gain 230mm Antenna.

2.2.2　Photodiode

The photodiode[1] can be found on page 2 (A1) of the schematic connected to the ADC. This photodiode is connected through the ADC to the ADCS system. This photodiode has a spectral sensitivity of $6.3nA/lx$ and the expected illuminance is on the order of $< 1Mlx$. This makes the expected voltage drop across the load resistor about $0.9V$.

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[1] CIS PN: 66-0003

2.2.3 Analog-to-Digital Converter

The ADC[2] is located on page 2 (A2) of the schematic. The ADC connects the photodiode to the ADCS for determining the location of the sun. The remaining ADC inputs are used to measure temperature at various locations on the board.

2.2.4 Antenna Deploy Release

The antenna release system is located on page 2 of the schematic. Four spring loaded flaps hold the antenna down before release. There are contacts on the flaps to verify if the flaps have been opened which will go high impedance when successfully deployed. The flaps are part of RF ground, forming the reflective ground plane for the helical antenna. The deployment system functions by cutting the monofilament used to tie the flaps down with high temperature 15Ω resistors. When the line is cut the springs push the flaps open and the antenna is deployed.

2.2.5 High Gain 230mm Antenna

The antenna contact is located on page 2 (A5) of the schematic. The antenna is helically shaped with a circular polarization. Made of super-elastic nitinol wire, the antenna springs out. The antenna is held down by 4 flaps for an irreversible deployment. Half power beam width of the antenna is 42.5° and the gain is 12.6 dB . The impedance is 150 Ω.

2.3 Board

The board shall be double layered with $1oz$ copper, ENIG finish, and $0.6mm$ thick.

2.3.1 Layout Constraints

Unless specified in the following subsections, all signals shall use the default parameters specified below. Signals in the following subsections do not include their sense signals unless specified. Trace width can be broken if a trace needs to bottleneck down to a pin, the bottleneck shall be minimized.

Trace width:	$0.2mm$
Vias:	$0.3mm$, unlimited count
Separation:	$0.2mm$
Length:	unlimited

2.3.1.1 I²C-I2C_[SDA, SCL]

Length:	Each node shall be length matched ±$1.0mm$
Stubs:	< $10.0mm$

2.3.1.2 RF Trace – LOW_GAIN_COAX

The 50Ω coax traverses through a quarter wave $\frac{\lambda}{4}$ transmission line of impedance $Z = \sqrt{(50\Omega)(150\Omega)} = 86.6\Omega$ to match the 150Ω impedance of the antenna.

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[2] CIS PN: 27-0003

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Track Width: 0.4 mm
Gap Width: 1.65 mm
Impedance: 86.6Ω
Length: 27.5mm

2.3.1.3   RF Ground

There will be a ground pour for RF ground.

3   Testing

All tests shall be performed at room temperature and not under vacuum unless otherwise specified. If any modifications are performed, take note. Include enough information to understand circuit behavior and for others to replicate the results. Include any software written to execute the test and link it in the test notes section. Save all software, waveforms, etc. in a subfolder of the board's test folder for each test.

- Waveforms shall be captured whenever appropriate
- Have the event take fill the screen (for fast events, zoom in; for slow events, zoom out)
- Label each channel accurately
- Only have bandwidth limiting if necessary for the test (this applies to the oscilloscope and probe settings)
- If ringing or overshoot occurs, use a ground spring or differential probe

Results location: https://github.com/CougsInSpace/CougSat1-Hardware/tree/master/CougSat1-RadioBoard/Testing/+XPanel.1.0

Common test instructions can be found on the wiki.

3.1   Antenna Deploy Release

Results: Pass / Fail
Configuration:

This test evaluates the circuit described in Antenna Deploy Release.

3.1.1   Test Instructions

Setup the antenna and flaps in the stowed position. Connect the EPS and Comms boards. Apply $3.7\,V$ to thermal knife resistors. Verify sense node changes from low to high. Verify antennas and flaps properly deploy.

3.1.2   Test Data

Test the antenna deployment release			
State	Property	Passing Criteria	Pass / Fail
Stowed	Sense node	$< 0.5V$	
Deployed	Sense node	$> 1.5V$	
Stowed	Antenna and flaps	Properly stowed	
Deployed	Antenna and flaps	Properly deployed	

3.1.3   Test Notes
Delete me if no notes are required.

3.2   Antenna

Results: Pass / Fail
Configuration:

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This test evaluates the circuit described in High Gain 230mm Antenna.

3.2.1 Voltage Standing Wave Ratio (VSWR)
Results: Pass / Fail

This describes how well the impedance is matched between source and load.

3.2.1.1 Test Instructions

Connect a directional coupler to the spectrum analyzer's input and tracking generator (TG) output. Run a sweep, $1.2GHz$ to $1.35GHz, 30kHz\ BW$ with the TG, normalize, and store this reference. There should be a flat line at $0dB$. Connect the antenna, the line should drop. Isolate the antenna as much as possible like space. Capture the antenna's response. Record the VSWR for $1.24GHz$ & $1.3GHz$.

$$VSWR = \frac{10^{\frac{return\ loss\ (dB)}{20}} + 1}{10^{\frac{return\ loss\ (dB)}{20}} - 1}$$

3.2.1.2 Test Data

Test the antenna's VSWR			
Frequency	VSWR	Passing Criteria	Pass / Fail
$1.24GHz$	Sense node	< 1.5	
$1.3GHz$	Sense node	< 1.5	

3.2.1.3 Spectrum Analyzer Plot

Add the antenna's response from the spectrum analyzer

3.2.1.4 Test Notes

Delete me if no notes are required.

3.2.2 Gain
Results: Information only

3.2.2.1 Test Instructions

Connect a $23cm$ dipole antenna to both the spectrum analyzer's input and tracking generator (TG) output. Separate the antennae by $1m$. Run a sweep, $1.2GHz$ to $1.35GHz, 30kHz\ BW$ with the TG, normalize, and store this reference. There should be a flat line at $0dB$. Connect the antenna to the TG output. The line should go up. Capture the antenna's response.

3.2.2.2 Test Data

Add the antenna's response from the spectrum analyzer

3.2.2.3 Test Notes

Delete me if no notes are required.

3.3 Photodiode

Results: Pass/Fail
Configuration:

This test evaluates the circuit described in Photodiode.

3.3.1 Test Instructions

Connect the ADC to the ADCS. Illuminate the photodiode with a bright light, measure the output voltage. Repeat with a dim light and a dark room. Verify the voltage changes accordingly

3.3.2 Test Data

Test the photodiode's response			
Light source	Voltage	Passing Criteria	Pass / Fail
Dark room Or shaded		$< 100mV$	
Dim light		Higher than V_{dark} $< 900mV$	
Bright light		Higher than V_{dim} $< 900mV$	

3.3.3 Test Notes

Delete me if no notes are required.

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