This document explains the function of the interposer, its schematic level design, its board level design, and its functional testing

Interposer

Revision 1.0.0

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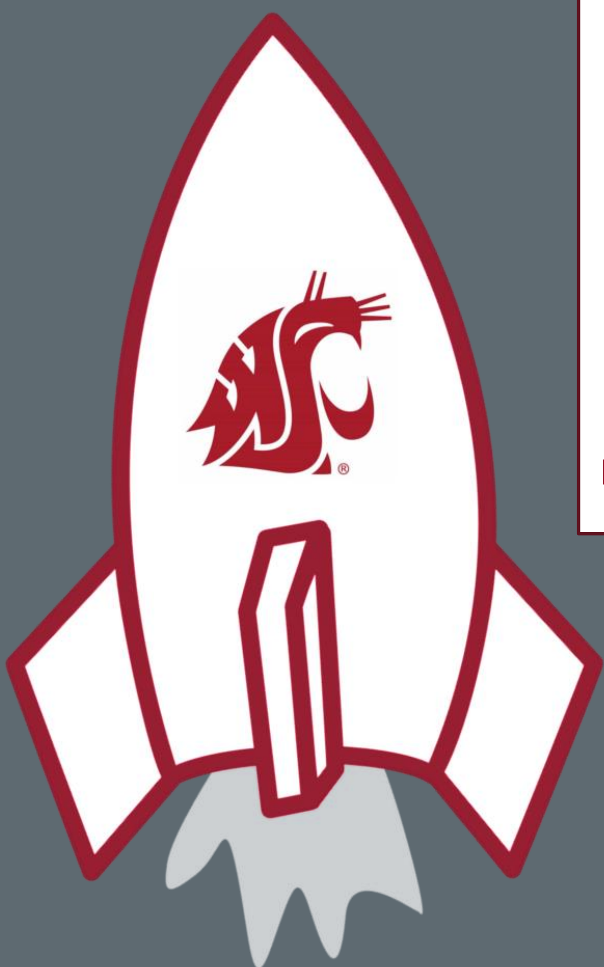

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1 Introduction

This document explains how the Germination Payload System will fulfill it's appropriate Function and conform to the necessary Requirements. Since the germination payload

1.1 Function

The system is responsible for the following:

- Enable a connection to the chamber board, *Plant*, from the backplane
- Monitor the experiment and collect data from the germination chamber

1.1.1 The Germination Experiment

The purpose of the experiment is to analyze how the germination of pea seeds is affected by microgravity compared to a control on Earth. This system has the control and monitoring circuitry required to carry out the said experiment. It is a system containing two boards, the board that is inside the germination chamber will be referred to as *Plant* throughout the rest of this document. The other board being the *Interposer*.

Plant is inside the pressurized germination chamber that contains $1\ atm$ of atmosphere. For this reason, *Plant* is connected to the backplane via an interposer. While allowing electrical power and communication transfer to *Plant* while preserving the pressurized integrity of the germination chamber.

1.2 Requirements

The system and design requirements for the interposer can be found on GitHub. Refer to the Payload requirements 003-008.

2 Detailed Description

This section references the Interposer 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 Illumination

There are four light emitting diodes on Plant. These LEDs emit light in the white portion of the visible spectrum. These render the experiment visible for the camera when pictures need to be taken.

2.1.2 Heating

The heater is the temperature regulator in and for the germination chamber. It also acts as a thermal knife that releases the water filled syringe which initiates the plant experiment.

2.1.3 Sensors

The following sensors are used to validate the experiment:

- CO_2 Sensor
- Pressure Sensor
- Temperature Sensor
- Humidity Sensor
- Camera

2.2 Schematic

2.2.1 Isolated Grounds

On page 3 of the schematic(A6), an isolated ground is found on the Interposer. Power ground (PGND) is directly connected to the backplane. It is shorted to PGND using a 0Ω resistor rated up to $2A$, the expected current is less than $50mA$.

2.2.2 Power Rails

Page 2 of the schematic illustrates the power rail on the Germination Payload system.

2.2.2.1 Camera Power Rail

The camera is powered by a dedicated sub-rail, Camera Power, which branches from 3.3 V-8. This is located on page 4, A3. This rail is active low and is designed as such to only let the camera draw power when taking pictures. It is switchable on and off to conserve power while maintaining normal functionality of the other components on the power rail.

2.2.2.2 Voltage Regulator

The carbon dioxide sensor in *Plant* requires a 4.5-5.5V power supply as specified in its datasheet. However, due to the restrictions of the 9-pin bulkhead, only one 3.3 V power rail is available. For this reason, a 5 V regulator is placed in *Plant*.

2.2.3 Signal Buffering

Busses that communicate with devices on different power rails go through a tri-state buffer, such that when the device is powered off, its ESD diodes do not hold the bus low preventing communication with the other devices on that bus.

The purpose of the buffer is to isolate the communication bus when, say, the camera is powered off so that the bus side is placed in a high-impedance state. The same circuit is used for when the camera is switched o

2.2.4 PWM Control

To control the average power dissipated by the heating and lighting circuits, a pulse-width modulated signal is used. This enables one to regulate the brightness of the LEDs and regulate the rate of heating in the germination chamber.

2.3 Board

The board shall be double layered with 1 oz copper and ENIG finish. The board shall also conform to the dimensions specified by the CougSat Module Standard.

2.3.1 Layout Constraints

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

Trace width:	$0.16mm$
Vias:	$\emptyset 0.3mm$, unlimited count
Separation:	$0.16mm$
Length:	unlimited

Devices with specific placement and routing considerations are called out on the schematic, see "CAD Note:"

2.3.1.1 *Camera Power Rails – 3.3V-8, PGND*

PGND Applies between the cameras and the backplane connector

Trace width:	$0.3mm$

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 test2.

• 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-Payload/Testing/Germ.1.0

Common test instructions can be found on the wiki.

3.1 Before First Power-On Check

Configuration:

This test shall be executed before any power is applied to the board.

3.1.1 Test Instructions

Measure the resistance of various points in reference to *PGND* located at the backplane. When measuring in-circuit resistances, flip the probes and take the lower value.

3.1.2 Test Data

Node	Resistance		Node	Resistance
3.3V-8			*AVDD*	
BOOST_OUT			*AVREF-0*	
5.0V				

3.1.3 Test Notes

Delete me if no notes are required.

3.2 5V Regulation

Configuration:
Result:

This test evaluates the circuit described in *Voltage Regulator*.

3.2.1 Output Voltage

3.2.1.1 Test Instructions

Apply $3.3V$ to *3.3V-8* at the backplane before executing this test. Measure the voltage of the 5.0V regulator at no load and at a $30mA$ resistive load.

Note: Measure the DC Component of the voltage with PLC[1] > 100.

3.2.1.2 Test Data

Measure the DC voltage at the output of the 5.0V regulator			
Load	Voltage	Passing Criteria	Pass / Fail
$No\ Load$		$4.900V < V < 5.100V$	
$30mA$		$4.900V < V < 5.100V$	

3.2.1.3 Test Notes

Delete me if no notes are required.

3.2.2 Output Ripple and Noise

3.2.2.1 Test Instructions

Apply $3.3V$ to *3.3V-8* at the backplane before executing this test. Measure the ripple of the 5.0V regulator at no load and at a $30mA$ resistive load.

Note: Measure the RMS value of the AC component with $f > 3Hz$.

3.2.2.2 Test Data

Measure the RMS ripple at the output of the 5.0V regulator			
Load	Ripple	Passing Criteria	Pass / Fail
$No\ Load$		$\lvert V_{ripple} \rvert < 25mV$	
$30mA$		$\lvert V_{ripple} \rvert < 25mV$	

3.2.2.3 Test Notes

Delete me if no notes are required.

[1] Power Line Cycles: DMM setting to average during 100 cycles of the 60Hz wall outlet

3.3 Camera

Configuration:
Result:

This test evaluates the Camera circuit described in Sensors.

3.3.1 Test Instructions

Apply $3.3V$ to both *3.3V-8* before executing this test.

Connect the camera to a microcontroller on *BUS_I2C1* and *BUS_SPI*. Take a photo with each. Include the photograph.

3.3.2 Test Data

Camera	Photo	Passing Criteria	Pass / Fail
Camera		Signal Integrity	

3.3.3 Test Notes

Delete me if no notes are required.

3.4 Other Sensors

Configuration:
Result:

This test evaluates the circuit described in Sensors.

3.4.1 Test Data

Sensor	Passing Criteria	Reading	Pass / Fail
CO_2	$0 - 2000ppm$		
Pressure	$101000 - 102000$		
Temperature	$26° C$		