Hendrik Melse

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

Camera Payload

Camera Payload Design

Revision: 1.1.0



Table of Contents

[1 Introduction 2](#_Toc20040727)

[1.1 Functions 2](#_Toc20040728)

[1.2 Requirements 2](#_Toc20040729)

[2 Detailed Description 3](#_Toc20040730)

[2.1 Functional Block Diagram 3](#_Toc20040731)

[2.1.1 Ionizing Radiation Sensor 3](#_Toc20040732)

[2.1.2 Particle Counter 3](#_Toc20040733)

[2.1.3 Cameras 3](#_Toc20040734)

[2.1.4 Temperature Monitoring 3](#_Toc20040735)

[2.2 Schematic 3](#_Toc20040736)

[2.2.1 Power Rails 3](#_Toc20040737)

[2.2.2 Isolated Grounds 3](#_Toc20040738)

[2.2.3 5V Regulation 4](#_Toc20040739)

[2.2.4 ADC 4](#_Toc20040740)

[2.2.5 Analog Voltage Reference And Supply 4](#_Toc20040741)

[2.2.6 Cameras 5](#_Toc20040742)

[2.2.7 Ionizing Radiation Sensor 5](#_Toc20040743)

[2.2.8 Particle Counter 5](#_Toc20040744)

[2.2.9 GPIO Expander 5](#_Toc20040745)

[2.3 Board 5](#_Toc20040746)

[2.3.1 Layout Constraints 5](#_Toc20040747)

[3 Testing 5](#_Toc20040748)

[3.1 Before First Power-On Check 5](#_Toc20040749)

[3.2 5V Regulator 5](#_Toc20040750)

[3.3 Analog Voltage Reference and Supply 5](#_Toc20040751)

[3.4 Temperature Monitoring 5](#_Toc20040752)

[3.5 Cameras 5](#_Toc20040753)

[3.6 Geiger Counter 5](#_Toc20040754)

# Introduction

This document explains how the Camera Payload will fulfill the following Functions and conform to the following Requirements.

## Functions

The Camera Payload is responsible for the following:

* Imaging Earth
* Counting ionizing radiation hits

## Requirements

The system requirements and Camera Payload design requirements can be found on [GitHub](https://github.com/CougsInSpace/CougSat1-Readme/blob/master/CougSat1-Requirements.pdf).

# Detailed Description

This section refers to the Camera Payload [schematic](https://github.com/CougsInSpace/CougSat1-Hardware/blob/master/CougSat1-Payload/Documentation/Payload-Camera.pdf). Page numbers will be listed and may have coordinates listed (number and letter combination found around the frame).

## Functional Block Diagram

The block diagram can be found on page 1 of the schematic.

### Ionizing Radiation Sensor

The Ionization Radiation Sensor is responsible for detecting high-energy photons and particles, and turning them into electrical signals.

### Particle Counter

The Particle Counter is responsible for counting the number of electrical pulses generated by the Ionizing Radiation Sensor.

### Cameras

The Cameras will take pictures of the Earth’s surface. There are two cameras on board, one with a wide-angle lens for taking large scale pictures, and another with a telephoto lens, for taking pictures of locations of interest, such as Pullman.

Data from the Cameras will be received and stored by the [C&DH](https://github.com/CougsInSpace/CougSat1-Hardware/blob/master/CougSat1-AvionicBoard/Documentation/C&DH-Design.pdf) subsystem.

### Temperature Monitoring

The Temperature Monitoring is carried out by an ADC connected to the [C&DH](https://github.com/CougsInSpace/CougSat1-Hardware/blob/master/CougSat1-AvionicBoard/Documentation/C&DH-Design.pdf) subsystem. The temperature of various components and at various points on the board are periodically measured and recorded.

## Schematic

### Power Rails

Page 2 of the schematic shows the various power rails used by the Camera Payload.

### Isolated Grounds

The 4 isolated grounds can be found on page 4 of the schematic. Power ground () is connected to the backplane and to the power devices (regulators). All other grounds are shorted to through a resistor rated up to . The expected current is led than . Digital ground () is connected to the digital components on the board, including the Counter, GPIO Expander, and Cameras. Analog ground () is connected to the analog components on the board, including the amplifiers and ADC. Chassis ground () is connected to the mechanical features of the satellite, including the bolt holes and card rails.

### 5V Regulation

The regulation can be found on page 3 of the schematic and contains two parts. The first is a switching mode boost converter[[1]](#footnote-1), chosen for its high efficiency. The feedback is set through a voltage divider such that the output is . The second part is a linear regulator[[2]](#footnote-2), chosen for its low noise and low dropout voltage, which will regulate the SMPS output down to and remove any ripple or noise introduced by the switching.

### Temperature Monitoring

The temperature monitoring ADC[[3]](#footnote-3) can be found on page 3 of the schematic. The ADC is an I­2C device which lives on *BUS\_I2C1*, and relays it’s data to the IHU. There are 8 single-ended inputs, all of which are reading thermistors from various locations on the board.

### Analog Voltage Reference and Supply

The Camera Payload has an analog voltage supply (Page 3, D3) fed by power rail *PR3.3-10* and filtered by a ferrite bead and capacitors. This powers the ADC and the reference voltage buffer. Precision on this rail is not required, as the ADC produces its own precision voltage reference. This voltage reference is fed through a unity gain buffer[[4]](#footnote-4) and used to power the thermistors.

### Cameras

The Cameras[[5]](#footnote-5) can be found on page 4 of the schematic. There are two cameras. The first has a wide-angle lens for taking large-scale photos of the earth, and the second has a telephoto lens, for taking images of locations of interest, such as Pullman or Area 51. Each camera uses the I2C bus *BUS\_I2C1* for receiving commands, and *BUS\_SPI* for transferring data. The cameras are operated by the C&DH[[6]](#footnote-6) subsystem.

### Ionizing Radiation Sensor

The ionizing radiation sensor[[7]](#footnote-7) can be found on page 4 (C1) of the schematic. The sensor itself is a photodiode primarily sensitive to radiation energies from about . The amplifiers are designed to amplify the signal from the photodiode so that the counter can read them. The exact design is taken directly from the white poper[[8]](#footnote-8) for the device, with a comparator added to the output to square up the output signal.

### Particle Counter

The particle counter is a 12-bit binary counter[[9]](#footnote-9) which counts the pulses from the sensor. The data is read by an I2C GPIO expander[[10]](#footnote-10) operated by the IHU on *BUS\_I2C1*. The same GPIO expander can be used to reset the counter.

## Board

### Layout Constraints

# Testing

## Before First Power-On Check

## 5V Regulator

## Analog Voltage Reference and Supply

## Temperature Monitoring

## Cameras

## Geiger Counter

1. CIS PN: [60-0007](https://github.com/CougsInSpace/Resources/blob/master/SupplierDocuments/60%20-%20Power%20IC/60-0007/TI_tps61220.pdf) [↑](#footnote-ref-1)
2. CIS PN: [60-0012](https://github.com/CougsInSpace/Resources/blob/master/SupplierDocuments/60%20-%20Power%20IC/60-0012/TI_tps732.pdf) [↑](#footnote-ref-2)
3. CIS PN: [27-0003](https://github.com/CougsInSpace/Resources/blob/master/SupplierDocuments/27%20-%20Conversion%20IC/27-0003/ANALOG_AD7291.pdf) [↑](#footnote-ref-3)
4. CIS PN: [08-0002](https://github.com/CougsInSpace/Resources/blob/master/SupplierDocuments/08%20-%20Amplifier%20(excluding%20RF)/08-0002/ANALOG_AD8515.pdf) [↑](#footnote-ref-4)
5. CIS PN: [66-0005](https://github.com/CougsInSpace/Resources/blob/master/SupplierDocuments/66%20-%20Sensor/66-0005/ArduCAM_Mini_5MP_Plus_OV5642_Camera_Module_DS.pdf) [↑](#footnote-ref-5)
6. [C&DH](https://github.com/CougsInSpace/CougSat1-Hardware/blob/master/CougSat1-AvionicBoard/Documentation/C&DH-design.pdf) [↑](#footnote-ref-6)
7. CIS PN: [66-0004](https://github.com/CougsInSpace/Resources/blob/master/SupplierDocuments/66%20-%20Sensor/66-0004/FIRSTSENSOR_x100-7-thd-501400%5B2%5D-203179.pdf) [↑](#footnote-ref-7)
8. [Photodiode white paper](https://github.com/CougsInSpace/Resources/blob/master/SupplierDocuments/66%20-%20Sensor/66-0004/gamma-ray-detection.pdf) [↑](#footnote-ref-8)
9. CIS PN: [28-0004](https://github.com/CougsInSpace/Resources/blob/master/SupplierDocuments/28%20-%20Logic%20IC/28-0004/TI_cd74hc4040.pdf) [↑](#footnote-ref-9)
10. CIS PN: [27-0001](https://github.com/CougsInSpace/Resources/blob/master/SupplierDocuments/27%20-%20Conversion%20IC/27-0001/TI_tca9535.pdf) [↑](#footnote-ref-10)