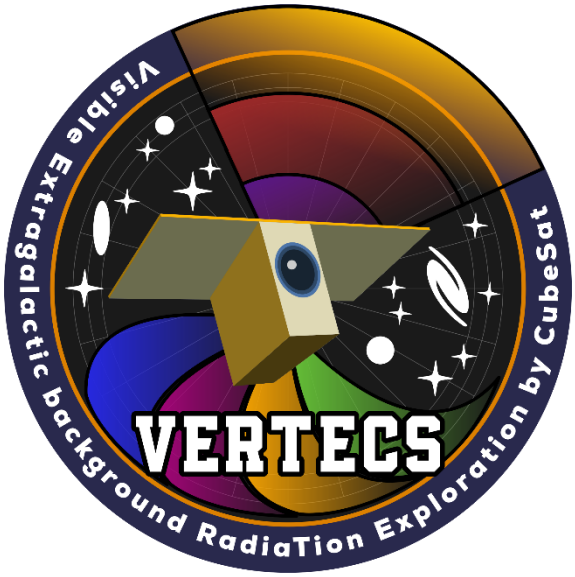
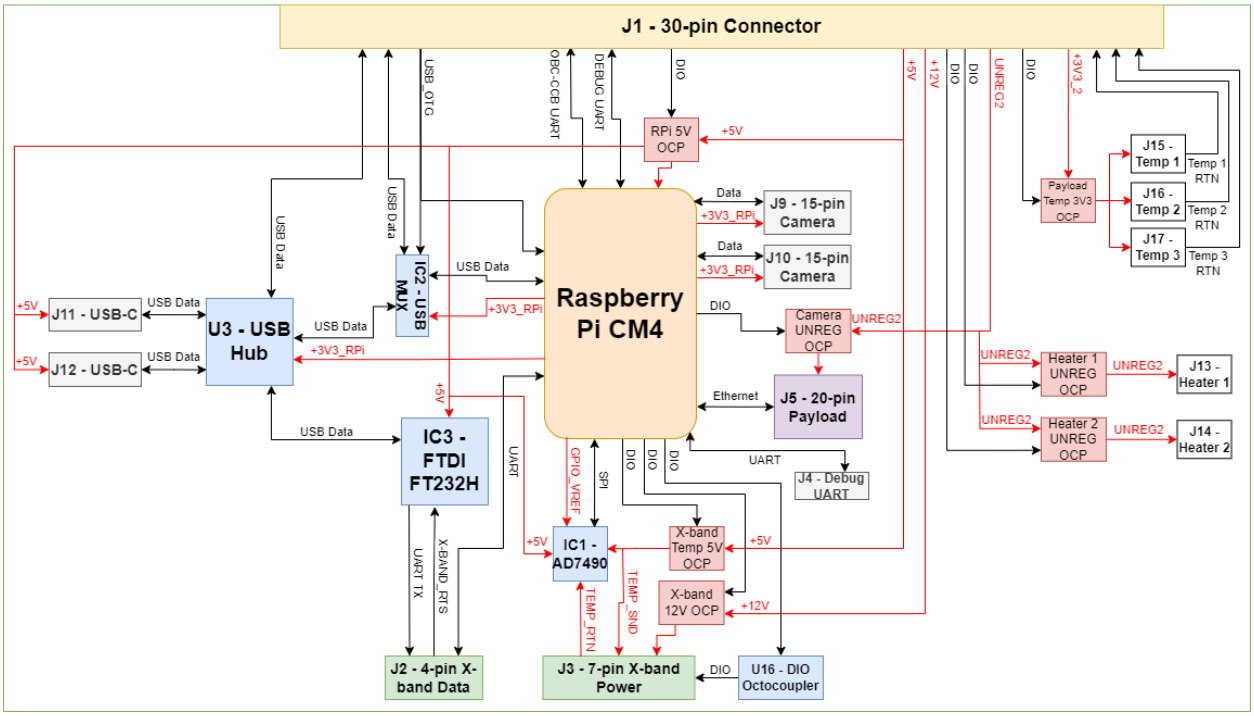


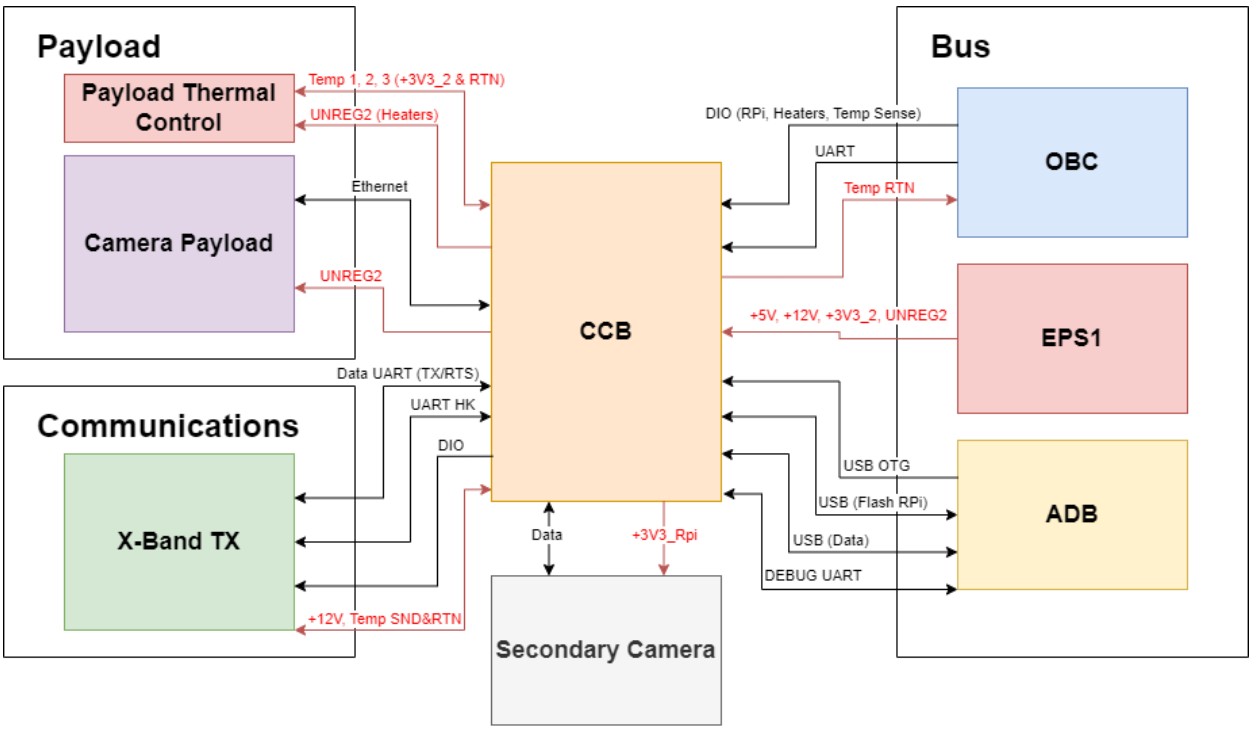
VERTECS Interface Control Document
Camera Control Board Subsystem

1. Overview of the subsystem

1.1. Subsystem Overview

The Camera Control Board (CCB) is designed to serve as a bridge between the VERTECS Bus and Payload. It is responsible for interfacing with the camera payload and the downlink of data via the X-band transmitter. Equipped with a Raspberry Pi Compute Module 4, it is capable of processing, managing, and storing mission data before eventual transmission to the ground.





1.2. General Requirements

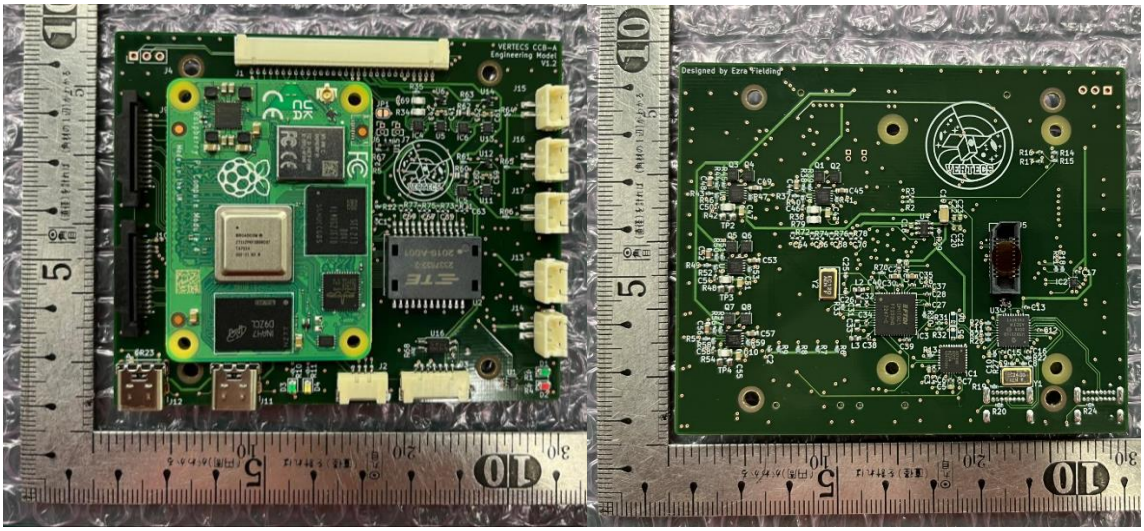
- SR-CCB1: CCB shall control the mission payload camera, including status check, power line check, exposure, and data collection.
- SR-CCB2: CCB shall control the secondary camera, including status check, power line check, exposure, and data collection.
- SR-CCB3: CCB is responsible for all the data transfer to the X-band transmitter.

1.3. Performance Requirements

- SR-CCB4: CCB can send data to the X-band transmitter at a speed higher than 5 Mbps.
- SR-CCB5: CCB shall have the data storage capacity for three-day observation data.

1.4. General Specifications

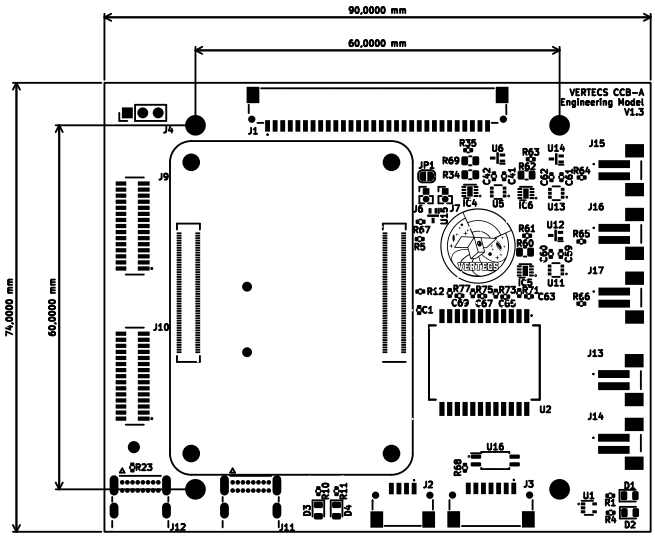
The CCB includes a Raspberry Pi CM4 with 32GB of EMMC flash storage and 8GB of RAM. Power and a gigabit ethernet connection, via the built-in networking capabilities of the CM4, are provided to the main camera payload through a 20-pin surface connector. To enable high-speed data transfer to the X-band transmitter, the CCB includes an FTDI FT232H UART chip connected to the CM4 via USB. Two USB-C ports are included on the CCB to allow for easier development, as well as additional payload capabilities for the satellite. Two 15-pin CSI camera connectors allow CSI cameras to be connected to the CM4. The main connection to the satellite bus is done over a 30-pin harness. Three 2-pin connections for temperature and two 2-pin connections for heaters are provided on the CCB for control by the main satellite Bus system.



2. Mechanical Interface

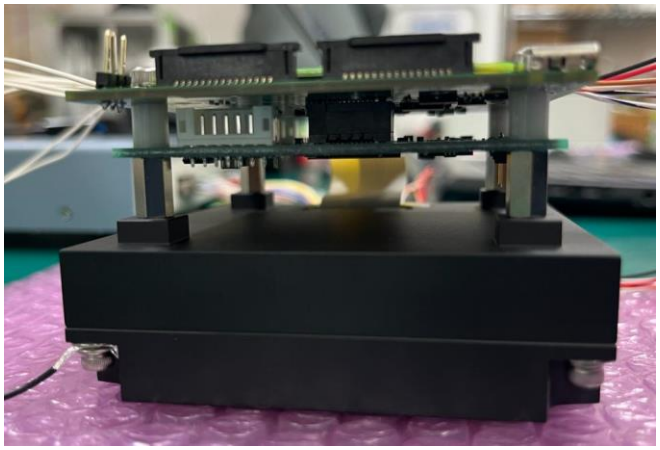
2.1. Dimensions

- Length: 90 mm
- Width: 74 mm
- PCB Thickness: 1.6 mm



2.2. Mounting Specifications

- Mounting Screw distance: 60 mm
- Mounting Screw Diameter: M3
- Distance between CCB and FPGA: 7 mm



3. Thermal Interface

The operating and storage temperature ranges (where available from the manufacturer) for mission critical ICs and components are given in the table below.

Part Reference	Part Number	Part Description	Operating Temperature (°C)	Storage Temperature (°C)
Module 1	Raspberry Pi CM4	Raspberry Pi CM4	-20 to +85	-
U2	2337822-2	Ethernet Magnetics	-40 to +105	-40 to +85
IC1	AD7490B	ADC	-40 to +85	-65 to +150
IC2	FSUSB42	USB MUX	-40 to +85	-65 to +150
U3	USB2514B-I	USB Hub	-40 to +85	-55 to +150
IC3	FT232HQ	FTDI UART	-40 to +85	-65 to +150

Considering the above information, the nominal operating temperature range for the CCB shall be -20°C to +85°C. Operation outside this range is possible, but performance and longevity cannot be guaranteed without further testing.

4. Electrical Interface

4.1. Pin Assignment

J1 – 30-pin Connector to Backplane (Hirose DF14-30P-1.25H(35))

30-pin Connector							
Pin No	Connection Name	Connector type	Voltage level	Max Current	Frequency / Baud Rate	Protocol	Comments
1	OBC-CCB_PWR_ON_DIO (MainPIC_to_CCB)	30-pin	3V3	-	-	-	OCP control for ON/OFF of RPi
2	OBC-CCB_UART (MainPIC_to_CCB)	30-pin	3V3	-	115200	RS232	Data receive from OBC
3	CCB-OBC_UART (CCB_to_MainPIC)	30-pin	3V3	-	115200	RS232	Data send to OBC
4	ADB-CCB_UART (ADB_to_CCB)	30-pin	3V3		115200	RS232	CCB Serial Terminal from ADB
5	CCB-ADB_UART (CCB_to_ADB)	30-pin	3V3	-	115200	RS232	CCB Serial Terminal to ADB
6	CCB-ADB_USBD0_P	30-pin	3V3	-	480Mbps	USB	For programming over USB-C
7	CCB-ADB_USBD0_N	30-pin	3V3	-	480Mbps	USB	For programming over USB-C
8	CCB-ADB_USBOTG	30-pin	5V	-	-	-	For enabling programming over USB-C
9	CCB-ADB_USBD1_P	30-pin	3V3	-	480Mbps	USB	For RPi USB data access
10	CCB-ADB_USBD1_N	30-pin	3V3	-	480Mbps	USB	For RPi USB data access
11	CCB-TEMP_DIO	30-pin	3V3	-	-	-	OCP control for ON/OFF of Temp Sensors
12	CCB-TEMP_ANALOG1	30-pin	3V3	1A	-	-	Analogue reading for temp sensor
13	CCB-TEMP_ANALOG2	30-pin	3V3	1A	-	-	Analogue reading for temp sensor
14	CCB-TEMP_ANALOG3	30-pin	3V3	1A	-	-	Analogue reading for temp sensor
15	CCB-HEATER_1_DIO	30-pin	3V3	-	-	-	OCP control for ON/OFF of Heater 1
16	CCB-HEATER_2_DIO	30-pin	3V3	-	-	-	OCP control for ON/OFF of Heater 2
17	GND	30-pin	0		-	-	GND
18	GND	30-pin	0		-	-	GND
19	SUP_5V0	30-pin	5V	3A	-	-	5V line to power RPi
20	SUP_5V0	30-pin	5V	3A	-	-	5V line to power RPi
21	SUP_3V3_2	30-pin	3V3	1A	-	-	3.3V for Temperature Sensors
22	SUP_3V3_2	30-pin	3V3	1A	-	-	3.3V for Temperature Sensors
23	SUP_UNREG_2	30-pin	8V4 (max)	4A	-	-	UNREG line for CAM and Heaters
24	SUP_UNREG_2	30-pin	8V4 (max)	4A	-	-	UNREG line for CAM and Heaters
25	SUP_12V0	30-pin	12V	3A	-	-	12V line for X-band
26	SUP_12V0	30-pin	12V	3A	-	-	12V line for X-band
27	GND	30-pin	0		-	-	GND
28	GND	30-pin	0		-	-	GND
29	NC*	30-pin					Tied to GND
30	NC*	30-pin					Tied to GND

*NC pins are tied to GND

J2 – 4-pin Connector to X-band Data (Hirose DF14-4P-1.25H(35))

4-pin Connector (X-band)							
Pin No	Connection Name	Connector type	Voltage level	Max Current	Frequency / Baud Rate	Protocol	Comments
1	XBAND_CONFIG	4-pin	3V3	-	115200	RS232	Configure X-band
2	XBAND_HK	4-pin	3V3	-	115200	RS232	HK Data receive from X-band
3	XBAND_RTS	4-pin	3V3	-	-	-	X-band RTS
4	XBAND_IN	4-pin	3V3	-	12000000	RS232	Data send to X-band

J3 – 7-pin Connector to X-band Power (Hirose DF14-7P-1.25H(35))

7-pin Connector (X-band)							
Pin No	Connection Name	Connector type	Voltage level	Max Current	Frequency / Baud Rate	Protocol	Comments
1	XBAND_DIO	7-pin	12V	-	-	-	X-Band direct ON/OFF control
2	XBAND_TEMP_SND	7-pin	5V	1A	-	-	X-Band analogue temperature power send
3	XBAND_TEMP_RTN	7-pin	5V	1A	-	-	X-Band analogue temperature return
4	SUP_12V0	7-pin	12V	1.5A	-	-	12V power to X-band
5	SUP_12V0	7-pin	12V	1.5A	-	-	12V power to X-band
6	GND	7-pin	0	-	-	-	GND
7	GND	7-pin	0	-	-	-	GND

J4 – 3-pin Header for Debug Terminal UART

3-pin Header (UART)							
Pin No	Connection Name	Connector type	Voltage level	Max Current	Frequency / Baud Rate	Protocol	Comments
1	CCB_TX	3-pin	3V3	-	115200	RS232	CCB Debug UART TX
2	CCB_RX	3-pin	3V3	-	115200	RS232	CCB Debug UART RX
3	GND	3-pin	0	-	-	-	GND

J5 – 20-pin Connector to Payload (Hirose ER8-20S-0.8SV-5H)

20-pin Connector (Payload)							
Pin No	Connection Name	Connector type	Voltage level	Max Current	Frequency / Baud Rate	Protocol	Comments
1	GND	20-pin	0	-			GND
2	GND	20-pin	0	-			GND
3	TX0_P	20-pin	12V	-	1Gbps	Ethernet	Digital interface to CAM
4	GND	20-pin	0	-			GND
5	TX0_N	20-pin	12V	-	1Gbps	Ethernet	Digital interface to CAM
6	TX1_P	20-pin	12V	-	1Gbps	Ethernet	Digital interface to CAM
7	GND	20-pin	0	-			GND
8	TX1_N	20-pin	12V	-	1Gbps	Ethernet	Digital interface to CAM
9	TX2_P	20-pin	12V	-	1Gbps	Ethernet	Digital interface to CAM
10	GND	20-pin	0	-			GND
11	TX2_N	20-pin	12V	-	1Gbps	Ethernet	Digital interface to CAM
12	TX3_P	20-pin	12V	-	1Gbps	Ethernet	Digital interface to CAM
13	GND	20-pin	0	-			GND
14	TX3_N	20-pin	12V	-	1Gbps	Ethernet	Digital interface to CAM
15	NC						
16	GND	20-pin	0	-			GND
17	NC						
18	NC						
19	UNREG_2	20-pin	8V4 (max)	2A	-	-	PWR for CAM FPGA
20	UNREG_2	20-pin	8V4 (max)	2A	-	-	PWR for CAM FPGA

J9 – 15-pin Connector to Secondary Camera (TE Connectivity 1-1734248-5)

15-pin Connector (Secondary Camera)							
Pin No	Connection Name	Connector type	Voltage level	Max Current	Frequency / Baud Rate	Protocol	Comments
1	GND	15-pin	0	-	-	-	GND
2	CAM0_D0_N	15-pin	3V3	-	-	Camera	Camera Data Line
3	CAM0_D0_P	15-pin	3V3	-	-	Camera	Camera Data Line
4	GND	15-pin	0	-	-	-	GND
5	CAM0_D1_N	15-pin	3V3	-	-	Camera	Camera Data Line
6	CAM0_D1_P	15-pin	3V3	-	-	Camera	Camera Data Line
7	GND	15-pin	0	-	-	-	GND
8	CAM0_C_N	15-pin	3V3	-	-	Camera	Camera Clock Line
9	CAM0_C_P	15-pin	3V3	-	-	Camera	Camera Clock Line
10	GND	15-pin	0	-	-	-	GND
11	CAM_GPIO	15-pin	3V3	-	-	-	Camera enable line from CM4
12	NC	15-pin			-	-	
13	SCL1	15-pin	3V3	-	-	I2C	I2C Clock Line
14	SDA1	15-pin	3V3	-	-	I2C	I2C Data Line
15	+3.3v	15-pin	3V3	600mA	-	-	+3.3v from CM4

J13 to J17 – 2-pin for Heater Power and Payload Temperature Sensors (Molex 55460-0272)

2-pin Connector (Heater) x2							
Pin No	Connection Name	Connector type	Voltage level	Max Current	Frequency / Baud Rate	Protocol	Comments
1	UNREG_2	2-pin	8V4 (max)	2A	-	-	UNREG PWR for Heater
2	GND	2-pin	0	-	-	-	GND
2-pin Connector (Temperature Sensor) x3							
Pin No	Connection Name	Connector type	Voltage level	Current	Frequency / Baud Rate	Protocol	Comments
1	GND	2 pin molex	0	-	-	-	GND
2	TEMP_READ	2 pin molex	3V	1A	-	-	Analogue reading for temp sensor