HASP Payload Specification and Integration Plan

Payload Title: Electrostatic Cosmic Dust Collector (ECDC)

Payload Class: **Small** Large (circle one)

Payload ID: 2016-02

Institution: College of the Canyons

Contact Name: Daniel Tikhomirov

Contact Phone: (661) 600-3270

Contact E-mail: Dtikhomi@gmail.com

Submit Date: 6/24/16

I. Mechanical Specifications:

A. Measured weight of the payload (not including payload plate)

i. **2000 grams** (4.41 lbs) maximum

Part	**Material**	**Weight (grams)**	**Uncertainty (+/- grams)**
Top Support Plate	Aluminum 6061	172g	+/- 10g
Bottom Support Plate	Aluminum 6061	150g	+/- 10g
Side Panel A	Aluminum 2024	50g	+/- 5g
Side Panel B	Aluminum 2024	50g	+/- 5g
Side Panel C	Aluminum 2024	50g	+/- 5g
Side Panel D	Aluminum 2024	50g	+/- 5g
Motor Bracket	Aluminum 6061	70g	+/- 10g
Liftarm	Aluminum 6063	20g	+/- 1g
Fasteners	Steel, Brass, Aluminum, Polycarbonate, Silicone	300g	+/- 10g
Assembled Firgelli Linear Actuator	Miscellaneous	45g	+/- 3g
Assembled EPC enclosure	Miscellaneous	500g	+/- 15g

Flight Computer	Miscellaneous	200g	+/- 10g
Power Control Board	Miscellaneous	50g	+/- 5g
Wires, Connectors, Sensors	Miscellaneous	15g	+/- 3g
Active Thermal System (heaters, sensors)	Miscellaneous	5g	+/- 1g
Passive Thermal System	mylar, aerogel blanket, polyimide film	100g	+/- 10g
High Voltage Converter	Miscellaneous	30	+/- 10g
Total	--	1850g (4.07lbs)	2000g max 1750g min

Table 1. ECDC Mass Measurements

B. Provide a mechanical drawing detailing the major components of your payload and specifically how your payload is attached to the payload mounting plate

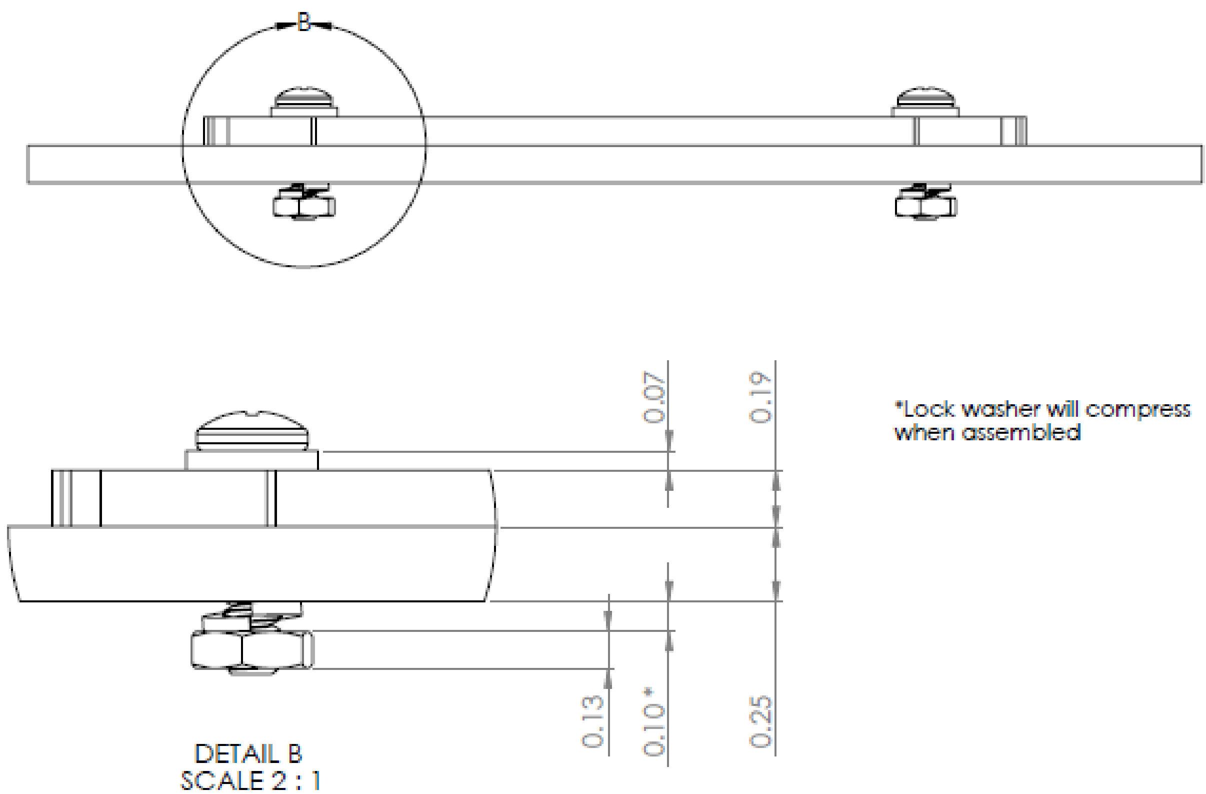
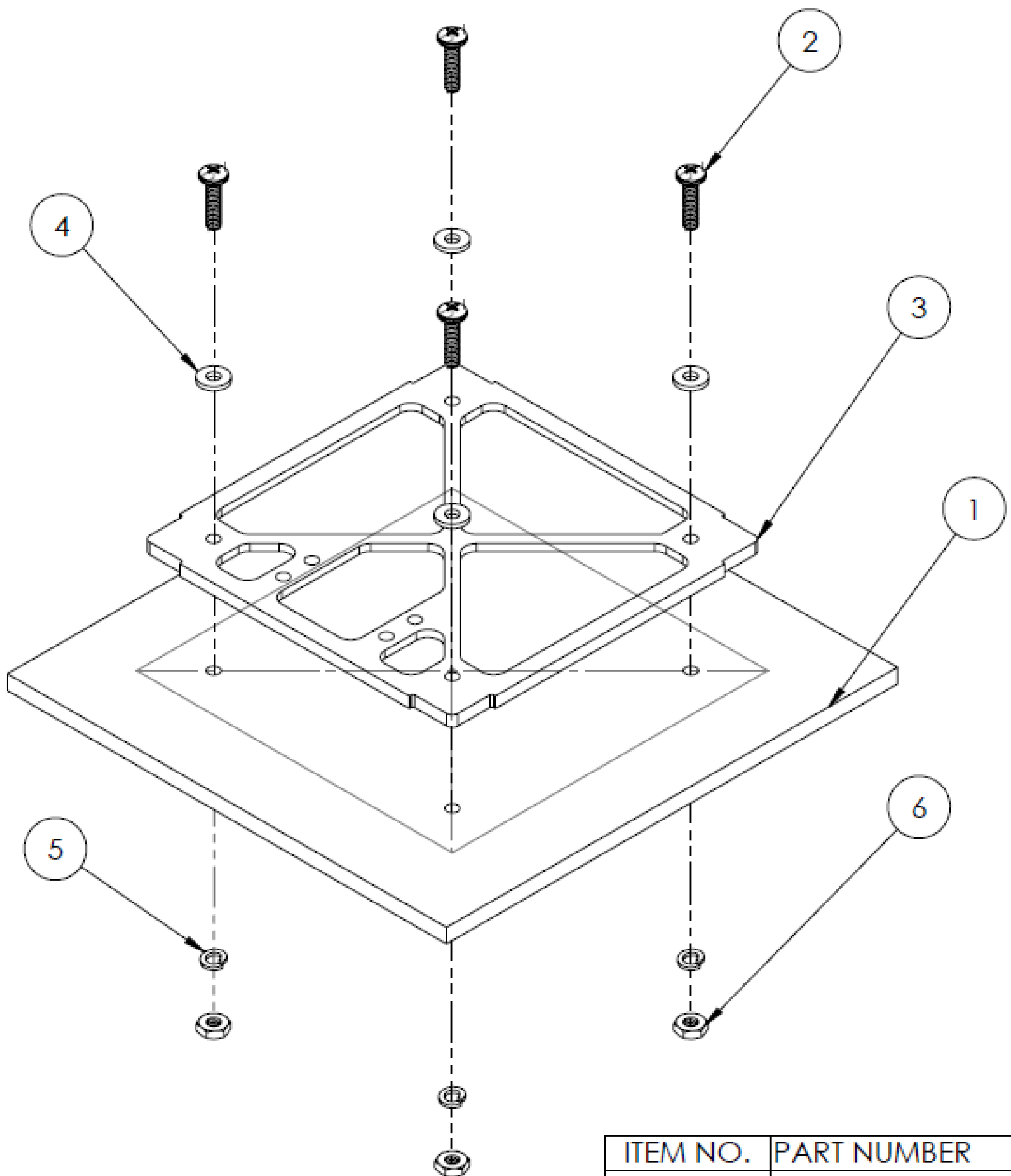


Figure 1. HASP integration fastener detailed view



ITEM NO.	PART NUMBER	QTY.
1	HASP_IntegrationPlate	1
2	10-24 Machine Screw	4
3	Bottom Support Plate	1
4	#5 Steel Washer	4
5	#5 Steel Lock Washer	4
6	10-24 Hex Nut	4

Figure 2. HASP integration fastener configuration

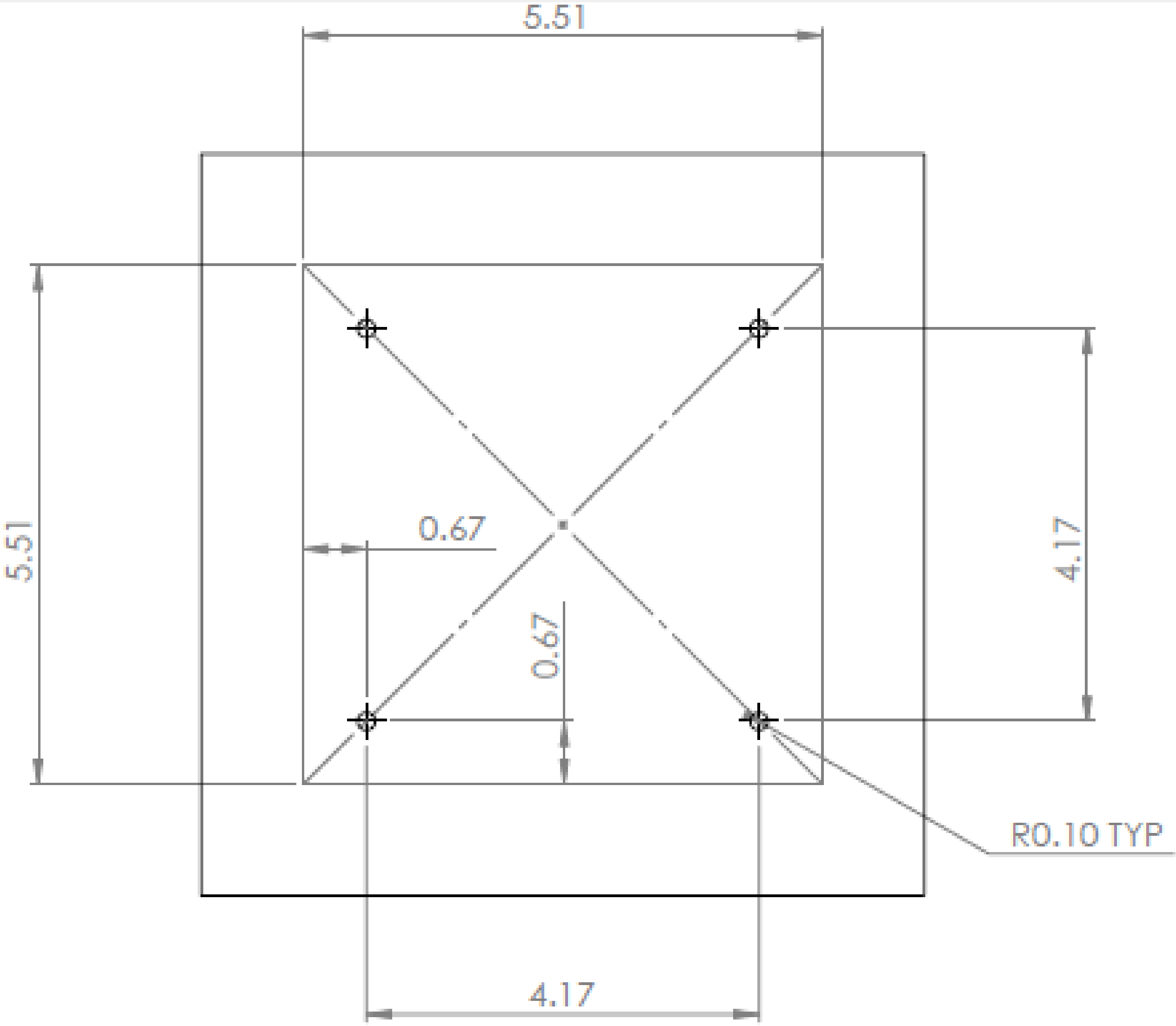


Figure 3. ECDC HASP integration plate modifications

*All dimensions are in inches

*The 4.17" x 4.17" spaced holes will be used for mounting the bottom support plate to the HASP integration plate with 10-24 (0.19" diameter) ¾" long machine screws with corresponding lock washers and nuts

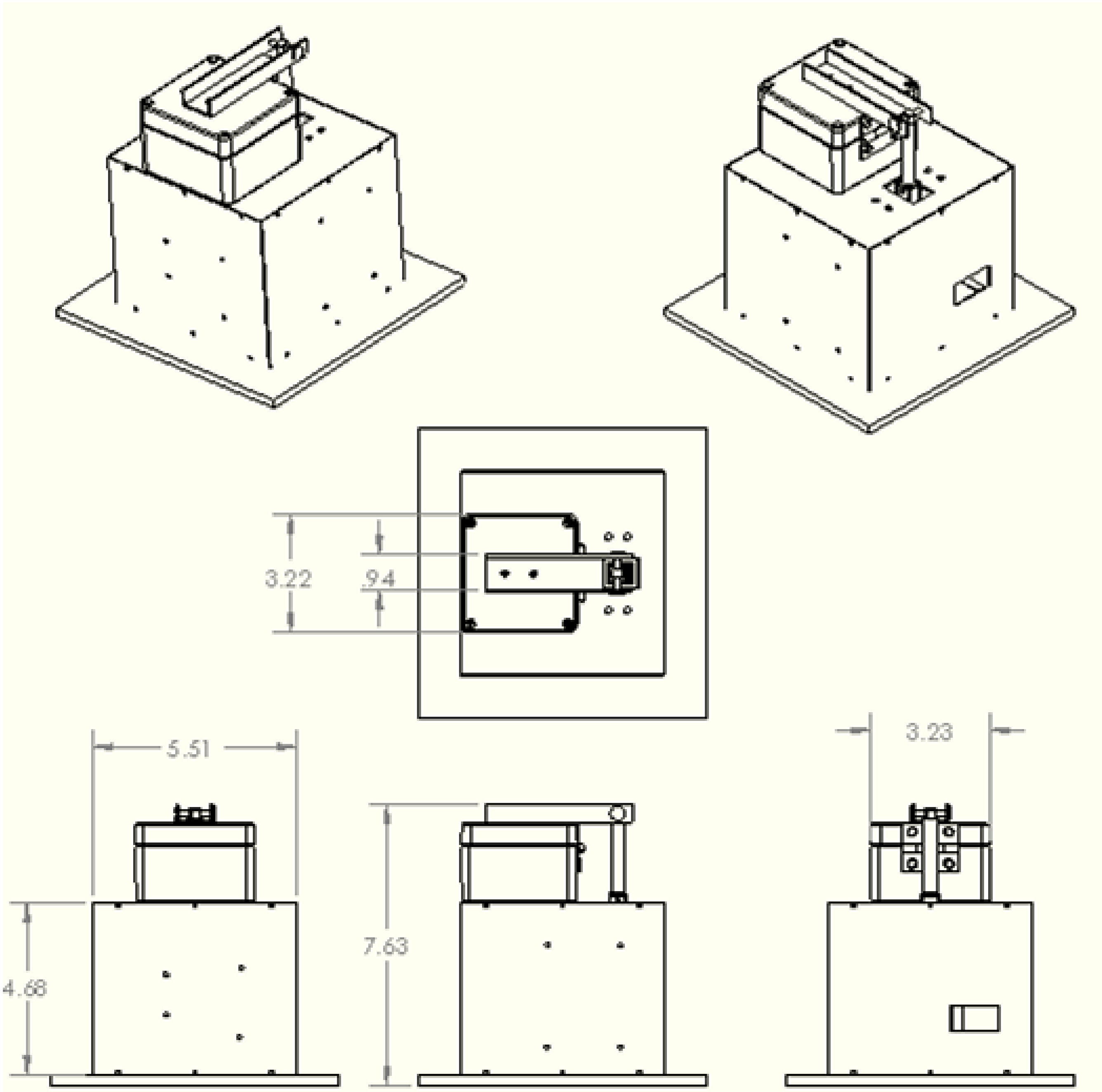


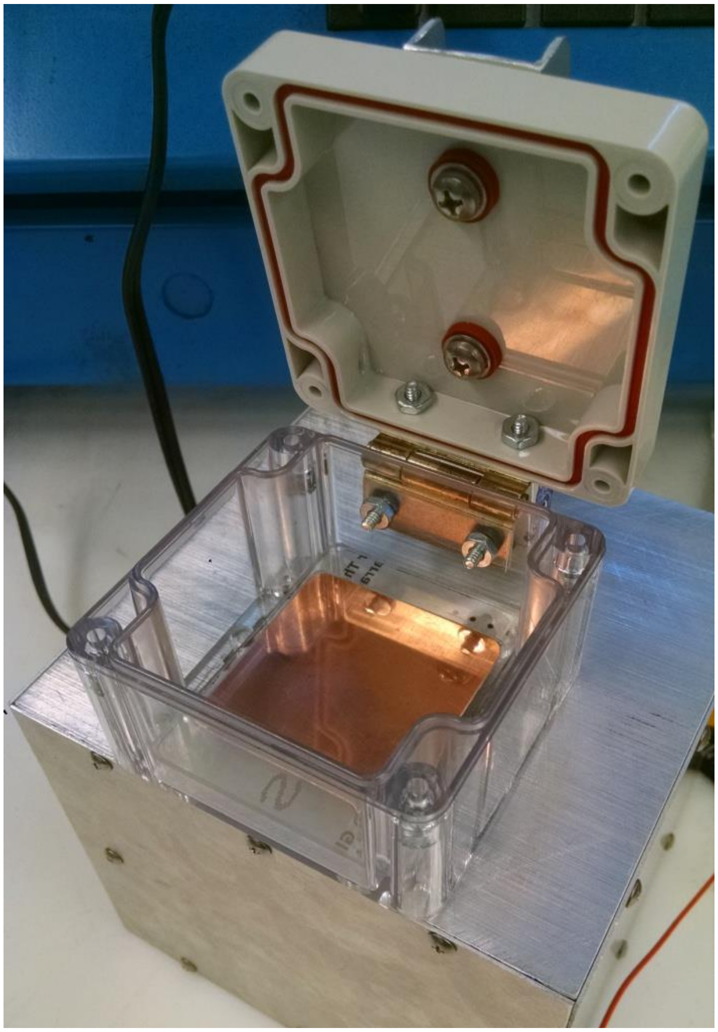
Figure 4. ECDC payload external dimensions

External Dimensions for the ECDC payload assembly during flight and integration are as follows:

Height**: 7.63** Inches (19.4cm) when EPC closed, **9.75** Inches (24.8cm) when EPC open

Width: 5.9 Inches (15cm)

Length: 5.9Inches (15cm)



The height dimensions for the payload are different due to the movement of the EPC's lid. The linear actuator (not shown) will compress, pulling down the liftarm and opening the EPC enclosure by approximately 75 degrees to the horizontal.

This movement will extend the height of the ECDC payload by 2.12 inches (5.4cm), making the overall height of the payload 9.75 inches; still within limits of HASP requirements of small payload height.

Figure 5. The test EPC enclosure fully opened during machine shop fabrication. A fully compressed linear actuator (not shown) opens the EPC enclosure ~75° from the horizontal

C. If you are flying anything that is potentially hazardous to HASP or the ground crew before or after launch, please supply all documentation provided with the hazardous components (i.e. pressurized containers, radioactive material, projectiles, rockets…)

  i. High Voltage Power Converter

    1. documentation for the Q101 XP-EMCO high voltage power converter will be included with this document upon submission

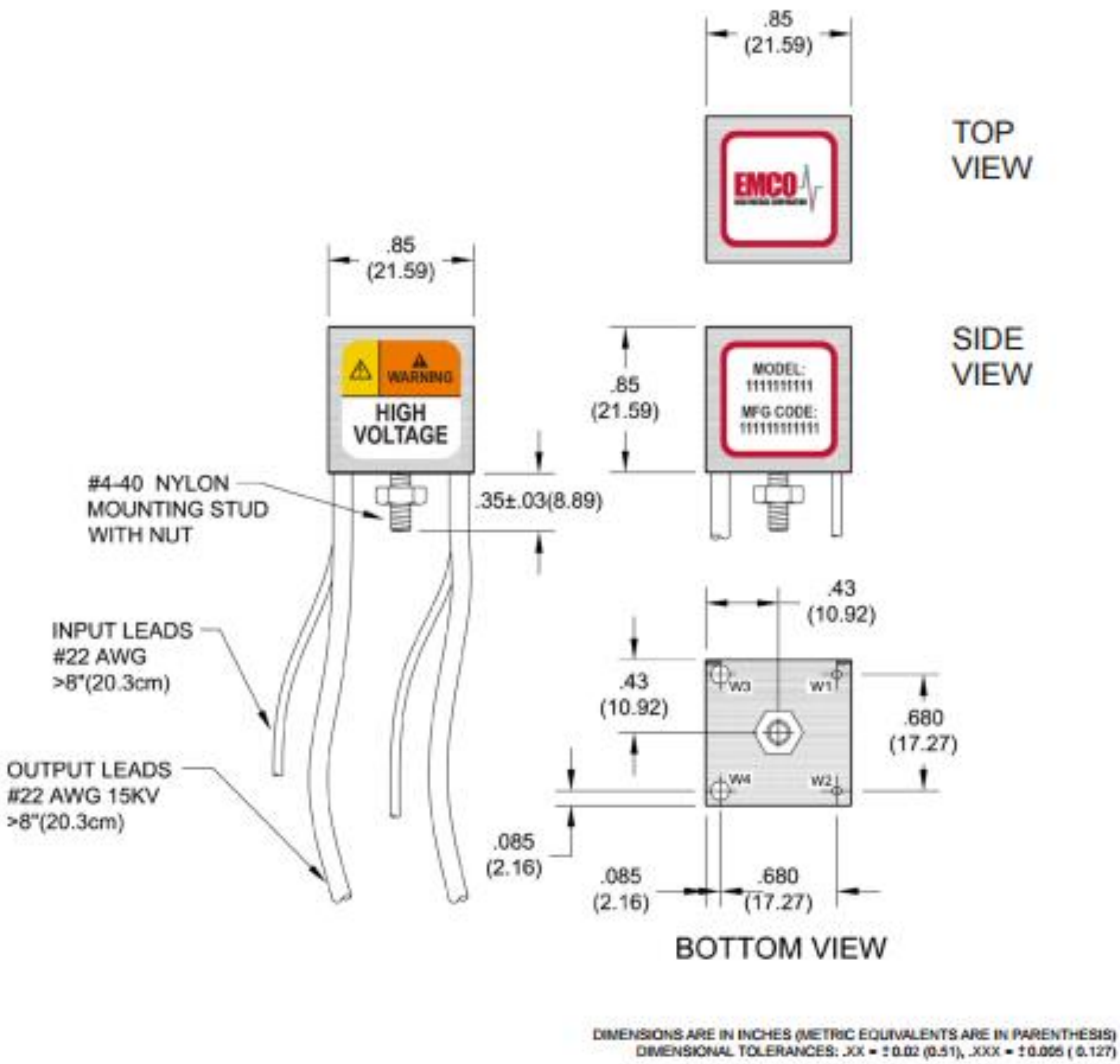


Figure 6. Q101 XP-EMCO high voltage power converter mechanical dimensions

Parameter	Value
Q Model	Q101
Input Voltage	5VDC
Output Voltage	10,000 VDC
Output Voltage Tolerance	+/- 10% (At 100% output, full load)
Maximum Input Current	NO-LOAD: <175 mA FULL-LOAD: <250 mA
Minimum Output Current	50 μA
Ripple P-P	<1.000%
Frequency	75-500KHZ (Typical)
Operating Temperature	-10°C to +60°C*4 (Case)
Isolation	< +/- 500 VDC bias on output return (W4)

Table 2. Q101 DC/DC Power converter specifications

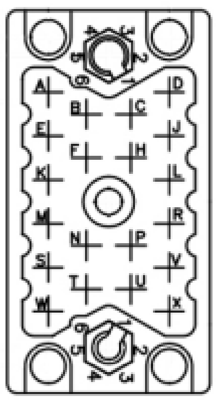
D. Other relevant mechanical information

II. Power Specifications:

A. Measured current draw at 30 VDC

   i. **0.27A** (absolute max)

B. If HASP is providing power to your payload, provide a power system wiring diagram starting from pins on the student payload interface plate EDAC 516 connector through your power conversion to the voltages required by your subsystems.



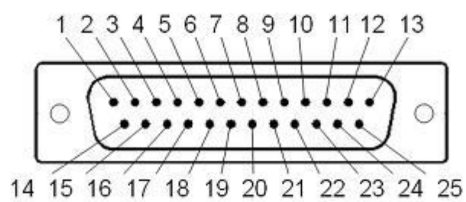


Figure 8. ECDC-HASP DB-25 Mating Plug

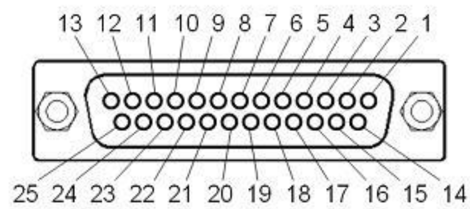


Figure 9. ECDC DB-25 Receptacle

Figure 7. HASP EDAC 516-020 Receptacle

Function	HASP EDAC 516 -020 Receptacle Pins	ECDC-HASP DB-25 Mating Plug	ECDC DB-25 Receptacle
+30V	A, B, C, D	14, 15, 16, 17	14
GND	W,T, U, X	22, 23, 24, 25	25
Analog 1	K	5	5
Analog 2	M	6	6
Signal Return	L, R	8, 9	8, 9
Discrete 1	F	19	19
Discrete 2	N	20	20
Discrete 3	H	4	4
Discrete 4	P	10	10

Table 3. HASP-to-ECDC Wiring Schematic

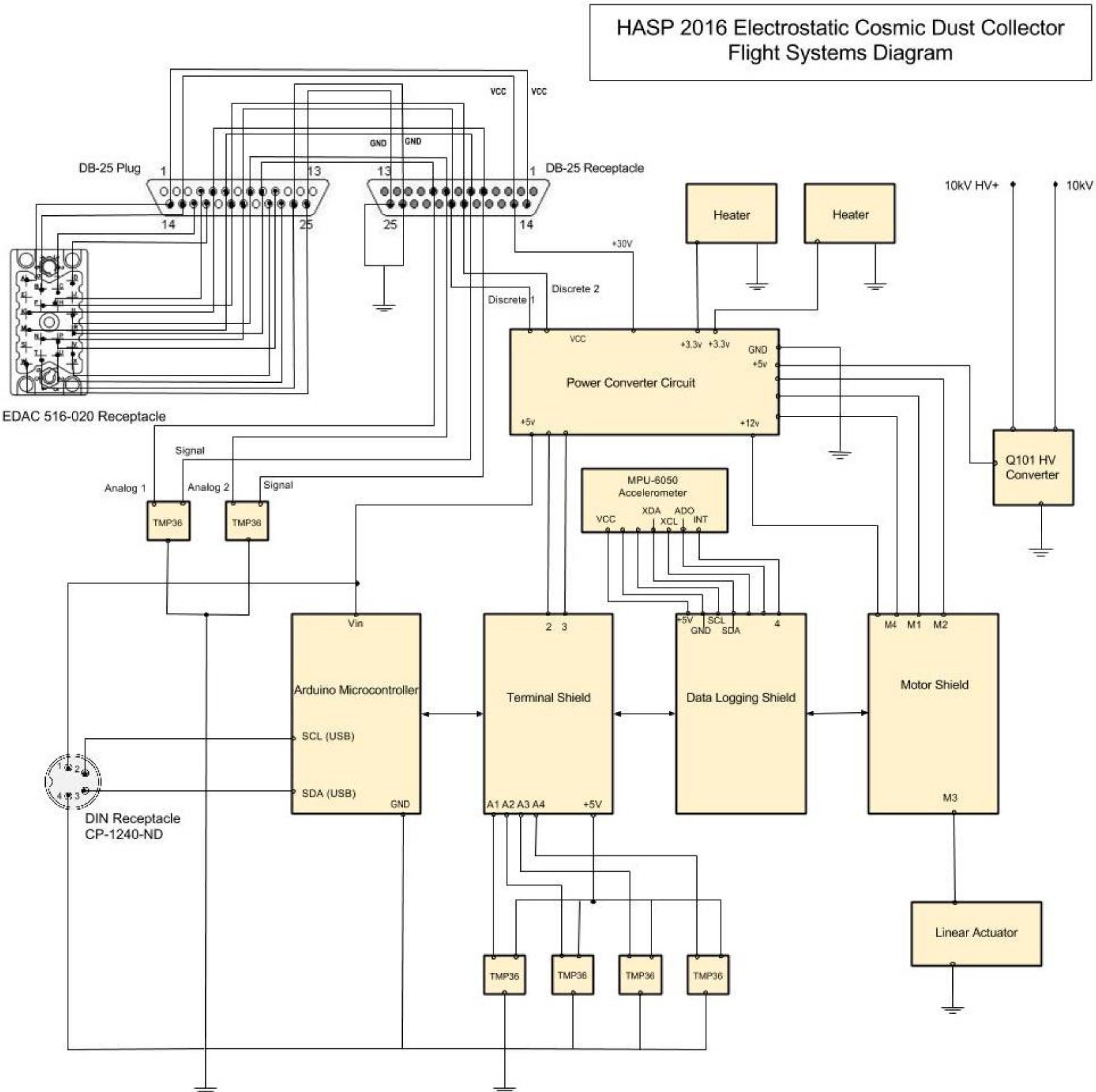


Figure 10. ECDC Flight Systems Block Diagram

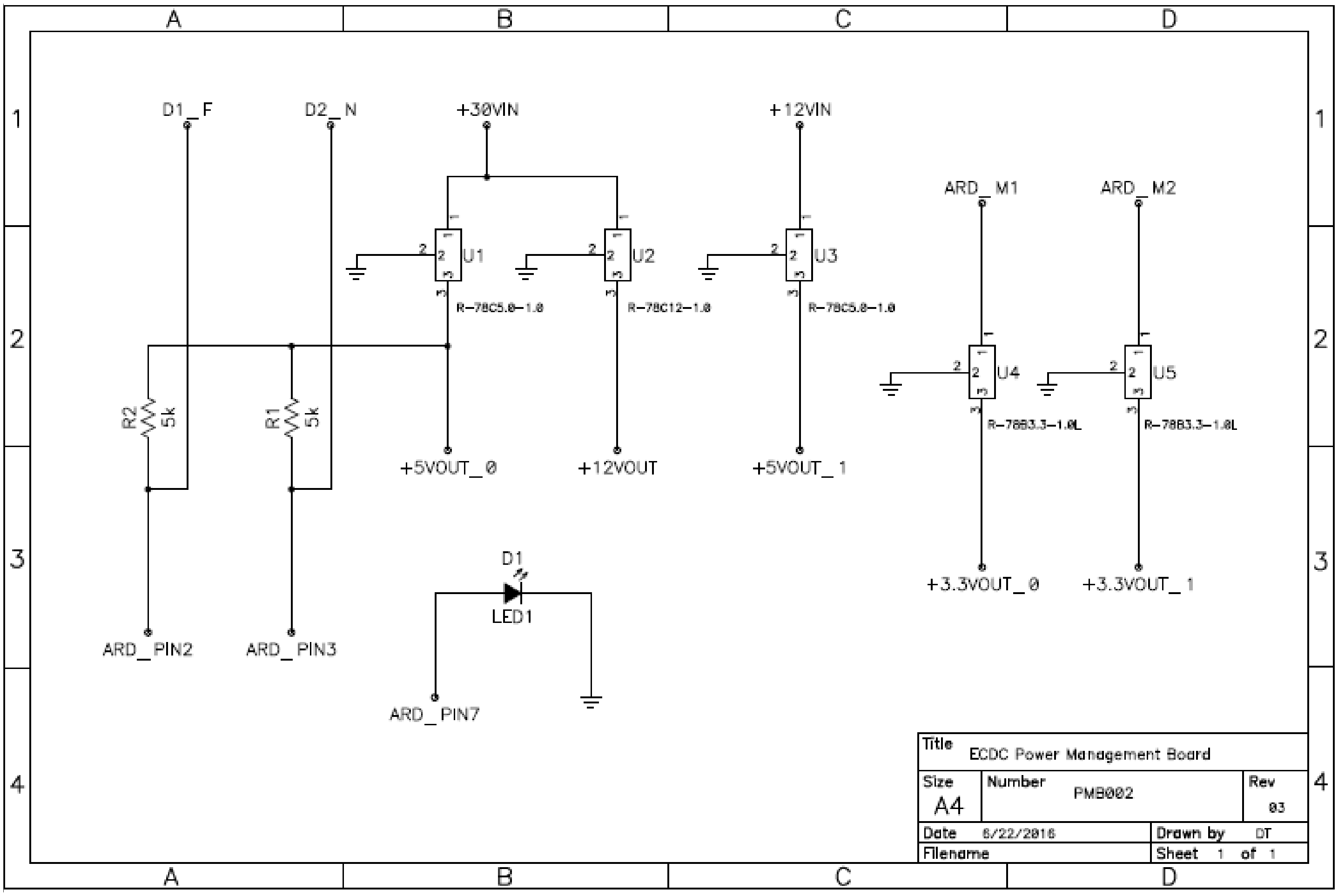


Figure 11. ECDC Power Management Board Schematic

Part Number	Manufacturer	Input Voltage	Output Voltage	Efficiency	Power (Watts)	Current (max)	Quantity
R-78C3.3-1.0	Recom Power	7-42VDC	3.3VDC	89%	3.3W	1A	2
R-78C5.0-1.0	Recom Power	8-42VDC	5VDC	93%	5W	1A	2
R-78C12-1.0	Recom Power	15-42VDC	12VDC	96%	12W	1A	1

Table 4. ECDC Power Management Board DC/DC converters specifications

System	Power Consumption	Uncertainty	Current	Operating Voltage
Flight Computer	0.64W	+/- 0.25W	80mA	5VDC
Temp. Sensors x6	<2mW	--	50µA	5VDC
Heaters x2	1.58W	+/- 0.5W	480mA	3.3VDC
Linear Actuator	1.35W	+/- 1W	270mA	5VDC
Accelerometer	1.8mW	--	500µA	3.6VDC
High Voltage Converter (10kV)	0.88W	+/- 0.13W	175mA	5VDC
Total	6.1W	8W max 4W min	--	--

Table 5. ECDC Power consumption

III. Downlink Telemetry Specifications:

A. Serial data downlink format: Stream Packetized (circle one)

   i. No serial downlink required

B. Approximate serial downlink rate (in bits per second)

C. Specify your serial data record including record length and information contained in each record byte.

Analog pin	**Reading Type**	**Voltage**	**Purpose**
#1 (K)	Temp. (C°)	0.1V(-40C°) - 1V (50C°)	Motor assembly temperature readings
#2 (M)	Temp. (C°)	0.1V(-40C°) - 1V (50C°)	High Voltage converter temperature readings

Table 6. Analog output usage

D. Number of analog channels being used:

   i. Analog #1 (K)

   ii. Analog #2 (M)

E. If analog channels are being used, what are they being used for?

   i. Analog #1: 0.1V-1V; Temperature measurement around motor assembly

   ii. Analog #2: 0.1V-1V; Temperature around the high voltage converter

F. Number of discrete lines being used:
  i. Discrete #1 (F)
  ii. Discrete #2 (N)

G. If discrete lines are being used what are they being used for?
  i. **Discrete #1**: Activates/Deactivates the linear actuator. The discrete signal sends a command through a pull-up resistor in the power management board to the flight computer. The flight computer interoperates the signal and commands the motor controller to turn on the linear actuator. The linear actuator then compresses and opens the EPC enclosure. A following signal after the expected exposure time will then follow the same steps to extend the linear actuator to close the EPC enclosure in preparation for flight termination.
  ii. **Discrete #2**: Activates/Deactivates the high voltage converter. The discrete signal sends a command through a pull-up resistor in the power management board to the flight computer. The flight computer interoperates the signal and commands the motor controller to turn on the high voltage converter. A following signal after the expected exposure time will then follow the same steps to deactivate the high voltage converter. Discrete pin #2 will be activated after the EPC enclosure opens and before the EPC enclosure closes for flight termination.

H. Are there any on-board transmitters? If so, list the frequencies being used and the transmitted power.
  i. There will be no on-board transmitters used
  ii. The Q101 high voltage power converter has minimal EMI and RF interference due to its high conversion frequency and low ripple.

I. Other relevant downlink telemetry information.

IV. Uplink Commanding Specifications:

A. Command uplink capability required: Yes **No** (circle one)

B. If so, will commands be uplinked in regular intervals: Yes No (circle one)

C. How many commands do you expect to uplink during the flight (can be an absolute number or a rate, i.e. *n commands per hour*)

D. Provide a table of all of the commands that you will be uplinking to your payload

E. Are there any on-board receivers? If so, list the frequencies being used.

F. Other relevant uplink commanding information.

V. Integration and Logistics

A. Date and Time of your arrival for integration:

   i. 10:00am, August 1st 2016 (flexible)

B. Approximate amount of time required for integration:

   i. 1-2 Hours

C. Name of the integration team leader:

   i. Daniel Tikhomirov

D. Email address of the integration team leader:

   i. Dtikhomi@gmail.com

E. List **ALL** integration participants (first and last names) who will be present for integration with their email addresses:

Name	Position/Role	Contact Information
Daniel Tikhomirov	Team Manager	dtikhomi@gmail.com
Mindy Saylors	Power Management Lead	MindySaylors@gmail.com
Patrick Gagnon	Mechanical/Structural Lead	pwgagnon@my.canyons.edu
Jason Monsalve	Flight Systems Lead	monsalve.jason@yahoo.com
Teresa Ciardi	Adviser	teresa.ciardi@canyons.edu
Greg Poteat	Adviser	Gregory.Poteat@canyons.edu

Table 7. HASP Integration participants list

F. Define a successful integration of your payload:

During HASP integration, the ECDC integration team will bring the following payload equipment:

1. The flight ECDC payload assembly.
2. The test ECDC EPC enclosure
3. The flight ECDC EPC enclosure

The flight ECDC payload assembly comprises of all assembled and flight-ready payload components excluding the EPC enclosure. The test ECDC EPC enclosure and the flight ECDC EPC enclosure are exactly identical and modular in the sense that they can be interchanged with relative ease. The only difference between the two enclosures is that the flight EPC enclosure has been cleaned and assembled in the clean room, while the test enclosure has not been.

During thermal vacuum chamber testing, the test EPC enclosure will be mounted to the ECDC payload structure and will undergo all the tests necessary for successful integration.

After the thermal vacuum chamber testing, the test EPC enclosure will be swapped with the flight ECP enclosure after which the payload may be deemed ready for flight.

A successful integration is defined by fulfilling all tasks in the expected integration steps and passing all checks that determine a successful integration.

G. List all expected integration steps:

1. Unpack the flight payload assembly from shipping packaging. Check for damaged components.

2. Attach the test EPC enclosure to the payload structure using 4 M4 (4mm) screws.

3. Connect wiring from the high voltage converter to the test EPC enclosure. Wires will be connected by splicing, therefore a soldering station and heat gun will be necessary.

4. Attach a testing DB-25 connector to the HASP-ECDC interface receptacle to provide the payload with 30V input voltage from a variable power supply.

5. Connect the side DIN 4-pin connector from the payload to a laptop using a USB interconnector. The laptop contains the flight program source code.

6. Upload flight program to the flight computer. Verify that the program is successfully running through the computer's serial monitor and observing the payload status light (ARD_PIN7 in figure .

7. Attach the payload to the HASP integration plate as shown in figures 1 & 2.

8. Detach the testing DB-25 connector and attach the official HASP EDAC 516-020 to DB-25 Plug to the HASP-ECDC interface receptacle.

9. Deliver the integration plate with mounted ECDC payload to HASP officials for further integration onto the gondola platform.

10. Thermal vacuum chamber testing:
    a. Test discrete pin 1 during thermal vacuum chamber testing to determine if the enclosure can open and close in the minimum temperatures and pressures expected during flight.

    b. Test discrete pin 2 during thermal vacuum chamber testing to determine if the high voltage converter can operate in the minimum temperatures and pressures expected during flight.

c. Verify that the analog temperature sensors are logging temperature data to the HASP flight computers.

11. Cut the high voltage wire at the slice, being sure to leave 6cm of extra wire on both ends of the splice.

12. Detach the test EPC enclosure from the payload structure by removing all M4 screws.

13. Attach the flight EPC enclosure to the payload structure by attaching 4 M4 screws.

14. Connect wiring from the high voltage converter to the flight EPC enclosure. Wires will be connected by splicing, therefore a soldering station and heat gun will be necessary.

H. List all checks that will determine a successful integration:

i. Payload is safely secured to the HASP integration plate with all electrical connections secured.

ii. Payload successfully functions during thermal vacuum chamber testing.

iii. High voltage converter is active with no short circuits or discharge present during the thermal vacuum chamber testing. The high voltage converter is able to turn on and off by discrete command signals at any time during flight.

iv. The linear actuator is able to open and close the enclosure assembly. The linear actuator is able to extend and compress by discrete command signals at any time during flight.

v. No fractures or strain is observed in the dynamic mission critical components during thermal vacuum chamber testing. Dynamic mission critical components include the motor assembly and EPC enclosure.

vi. Analog temperature signals are read and relayed through the HASP analog pins

vii. The active thermal control system is able to maintain a stable, constant temperature within the motor assembly and the high voltage converter enclosure at operating temperature for the components.

I. List any additional LSU personnel support needed for a successful integration other than directly related to the HASP integration (i.e. lifting, moving equipment, hotel information/arrangements, any special delivery needs…):

The flight Electrostatic Particle Collector (EPC) will be assembled and cleaned in a class 1000 clean room prior to shipment to HASP facilities for integration.

A clean box or temporary clean room of a class 1000 or lower (lower class means cleaner work area) will be needed for HASP integration. However if a clean space of class 1000 or lower cannot be found in time for HASP integration in August, it shouldn't mean a mission failure for the ECDC payload. The clean space will be used primarily for inspection or repairs of the flight EPC enclosure if necessary. The ECDC integration team can do without the clean space, although it would be a good precaution if contamination were to occur. If further specifications or details on the clean space are required, please contact the team manager, Daniel Tikhomirov.

As for ECDC payload shipment to the CSBF facility or LSU (whichever preferred), College of the Canyons will handle all shipment expenses and needs. All that is required is the necessary shipment address and requirements prior to shipment.

Immediate shipment of the payload upon landing recovery will be necessary for ECDC mission success; more information to be provided in the upcoming FLOP document. Packaging equipment and postage will be brought with the ECDC integration team during HASP integration.

J. List any LSU supplied equipment that may be needed for a successful integration:

i. Class 1000 (or lower) clean space, if available

ii. Multimeter/Oscilloscope

iii. Variable power supply (0.5 - 32Vdc); 1 output

We used the Tekronix PS280 in the lab. However any power supply that can successfully mimic the HASP output voltage will be sufficient.

iv. Soldering/de-soldering station

v. Heat gun

vi. Wire stripper

vii. Crimping tool

viii. Test leads for multimeter, oscilloscope, and power supply