HASP Payload Specification and Integration Plan V2

Payload Title: SHADOMS (Stratospheric Hypersonic Atomospheric Dust particle Optical Measurement System)

Payload Class: Small Large (circle one)

Payload ID: 2019-01

Institution: University of Minnesota- Twin Cities

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Submit Date: 6/21/2019

I. Mechanical Specifications:

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

Part	Mass (g)	Uncertainty (g)
LOAC recording unit	730	2
OPC N3 sensor	108	2
PMS5003 sensor	42	2
Flight computer	278	2
Structure	960	2
Passive and active heating	60	2
Total	**2178***	**12**

Table 1. Mass budget and total payload mass, including uncertainty.

*This is the weight measurement of the actual payload.

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

Mechanical drawings are shown in the Appendix of Mechanical Drawings. A table of figures is provided here. All mechanical drawings have units of millimeters.

i. Figure A1. Diagram of assembled payload with invisible top and side walls.

ii. Figure A2. Mechanical drawing of back wall.

iii. Figure A3. Mechanical drawing of left wall.

iv. Figure A4. Mechanical drawing of front wall.

v. Figure A5. Mechanical drawing of right wall.

vi. Figure A6. Mechanical drawing of bottom plate.

vii. Figure A7. Mechanical drawing of top plate.

viii. Figure A8. Mechanical drawing of side connectors.

ix. Figure A9. Mechanical drawing of top connectors.

x. Figure A10. Diagram of assembled payload with sensors showing.

xi. Figure A11. Diagram of assembled payload with mounting style shown.

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…)

Each optical particle counter houses a class 3B laser that is used for counting and sizing particles as they move through the flow channel. These lasers are completely self contained and should not be a hazard to any systems on the HASP gondola, the balloon, or any of the surrounding payloads. The containment makes the respective laser packages of class 1R. The laser in the LOAC operates with a power draw of 0.025W at a wavelength of 0.00065mm. The laser in the Alphasense N3 operates between 0.005W and 0.008W at a wavelength of 0.000685mm. The PMS-3005 system operates at 0.5W. The power and wavelength of the laser are unknown.

D. Other relevant mechanical information

The payload uses a shell of five layers of mylar as a passive heating system. These layers help to limit temperature fluctuations by preventing heat loss or gain from radiation during and after flight in the tropopause respectively. In addition, the payload has an active heating system using a 5 x 15 cm SparkFun heating pad, which relies on a temperature sensor to efficiently supply heat to the payload as necessary. If the temperature sensor reads a drop below 283 kelvin, the heater will turn on until the temperature has warmed the region to 289 kelvin and then turn off again.

II. Power Specifications:

A. Measured current draw at 30 VDC

The following table provides peak current draws of electrical components taken at their respective operating voltages.

Component	Current (mA)	Voltage (V)	Power (W)
OPC-N3	180	5	0.9
LOAC	500	12	6
PMS-5003	100	5	0.5
Flight Computer	80	5	0.4
Board Based Sensors	56	5	0.28
Active Heating	600	5	3
Total	**359**	**30**	**11.08**

Table 2. Power budget with currents and voltages.

The next table provides the peak current draws after accounting for inefficiencies in the DC/DC converters, and accounting for an extra 10% error.

Voltage	Efficiency	Current (mA) with Efficiency	Current w/ Uncertainty (+10%) (mA)	Power with Efficiency (W)	Power w/ Uncertainty (+10%) (W)
5V	90%	1128	1241	5.64	6.21
12V	89%	562	618	6.74	7.42
Total (30V)	**-------**	**413**	**454**	**12.38**	**13.63**

Table 3. Total current draw with conversion efficiencies

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.

The power system wiring layout is provided in Figure 1 below. From the EDAC connector, only pins A, B, C, D for +30V and pins T, U, W, X for ground are utilized by the payload. **The HASP 30V supply is fed into the SHADOMS power conversion board which steps it down to the 5V and 12V buses using two PYB15-T DC/DC converters. These converters are rated from -50C to 80C.** These buses are then made available to all other electrical components on the payload. The Teensy 3.5 flight computer utilized the 5V bus to create a 3rd 3.3V bus for powering on board sensors such as the GPS module and temperature sensors.

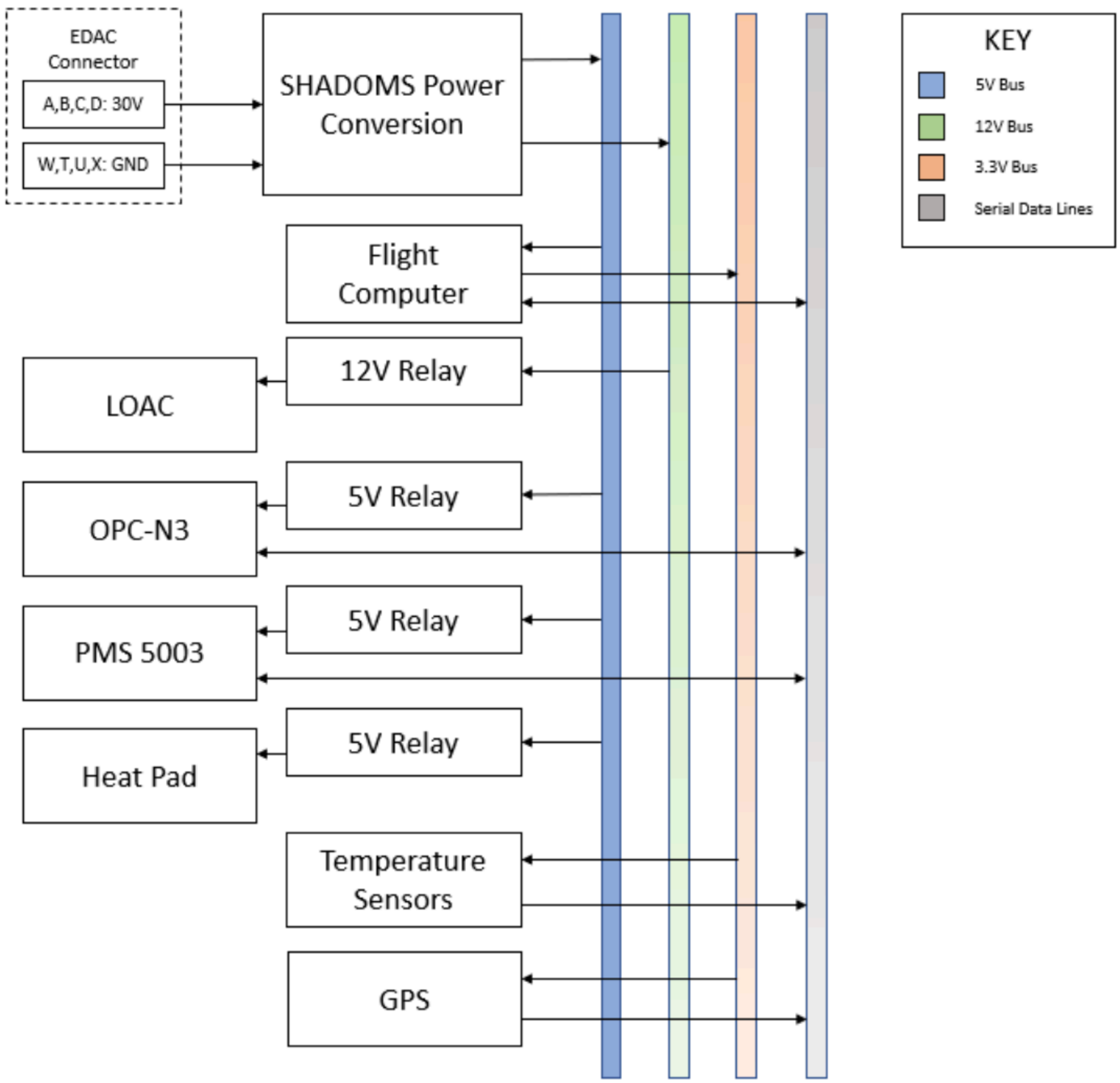


Figure 1. Power system wiring diagram.

The full circuit diagram is in appendix B.

C. Other relevant power information

N/A

III. Downlink Telemetry Specifications:

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

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

SHADOMS will initiate data transfer at a frequency of 0.14 Hz. The data packets sent via the serial downlink will be of the structure shown in section C below. This implies 60 bytes of data will be sent every 7 seconds, 60 bits per second including start and stop bits.

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

Byte	Title	Description
1-2	Checksum	Leading checksum for downlink
3-10	Time	Time string in HH:MM:SS since power-on
11-15	Latitude	Latitude from Copernicus II GPS
16-21	Longitude	Longitude from Copernicus II GPS
22-30	Altitude	Altitude from Copernicus II GPS
31-36	Ext_Temp	Temperature of the Teensy 3.6 microcontroller
37-42	Temp_N3	Temperature of the LOAC sensor
43-48	Temp_PCB	Temperature of the OPC-N3 sensor
49-54	PMS_sample	Sample of data from PMS

55-56	Sign Flags	Signs of Latitude and Longitude data (+/-)
57	State_OPC	State of OPC's
58	State_Flight	State of flight
59-60	Checksum	Ending checksum for downlink

Table 3. Serial data packet structure

Sample Data String (60 bytes)
UM01:35:4435.66105.97104324.85103.45156.43234.55###2450111@@

Table 4. Sample data string. Each character represents a single byte. The data is initially combined into 1 large string. The characters in the string are then converted to bytes corresponding to their ASCII values and the bytes are then sent one after the other.

D. Number of analog channels being used:

   None

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

   N/A

F. Number of discrete lines being used:

   None

G. If discrete lines are being used what are they being used for?

   N/A

H. Are there any on-board transmitters? If so, list the frequencies being used and the transmitted power.

   None

I. Other relevant downlink telemetry information.

   N/A

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*)

We expect to send no more than four commands total.

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

Command	Byte 1	Byte 2	Description
System Reset	0x1C	0xAA	Cycles the OPC's in the event of an error.
OPC Activation	0x1C	0xBB	Activates the OPC's
OPC Shutdown	0x1C	0xCC	Shuts down OPC's

Table 5. Table of commands for uplink.

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

None

F. Other relevant uplink commanding information.

N/A

V. Integration and Logistics

A. Date and Time of your arrival for integration:

Arriving the morning of July 15th, 2019

B. Approximate amount of time required for integration:

The required time for each of the following integration steps:

- Mechanical connection: This depends on how long it takes the HASP personnel to attach the mounting plate to the gondola. This will take 10 minutes.
- Power connection: We will connect all of the relevant cables from the mounting plate to the HASP Gondola. This will take 2 minutes.
- Testing: The data collection system will be turned on using HASP gondola commands. LEDs will indicate the success of this test. This test will take 5 minutes.

The total time estimate for integration is 17 minutes

C. Name of the integration team leader:

Nathan Pharis

D. Email address of the integration team leader:

Phari009@umn.edu

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

Nathan Pharis- phari009@umn.edu

David Richardson- rich1299@umn.edu

PJ Collins- coll0792@umn.edu

Jacob Meiners- meine042@umn.edu

F. Define a successful integration of your payload:

A successful integration will be a ready-to-fly payload that fulfills the tests and requirements outlined in the Payload Integration Certification procedure. After the integration is complete, all of the power systems will turn on and the downlink system will connect. Furthermore, a successful integration will include a proper calibration of all particle sensors on the ground that provides a proper baseline for data collection. Background data will be collected during the initial integration and during the thermal vacuum tests. We will check this by examining data collected through the downlink capabilities to ensure that the particle counters are active. Furthermore, the GPS and temperature sensors will be active- this will be checked through health packets sent through the downlink system.

G. List all expected integration steps:

1. Presenting required documentation
2. Final weighing of payload
3. Connecting payload to HASP power and downlink
4. Testing power draw from HASP system
5. A thermal and vacuum test with test operation of the payload

   During the thermal vacuum test, check the payload data collection to ensure that all systems are functioning, that the active heating is engaging, and that the GPS is sending data.

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

- Fulfills requirements for Payload Integration Certification
  - The power, weight, and size requirements are all met
- All on-board particle counters are calibrated and reading the same values on the ground and during tests.

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…):

   N/A

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

   N/A

Appendix A- Mechanical Drawings (All drawings are in units of millimeters)

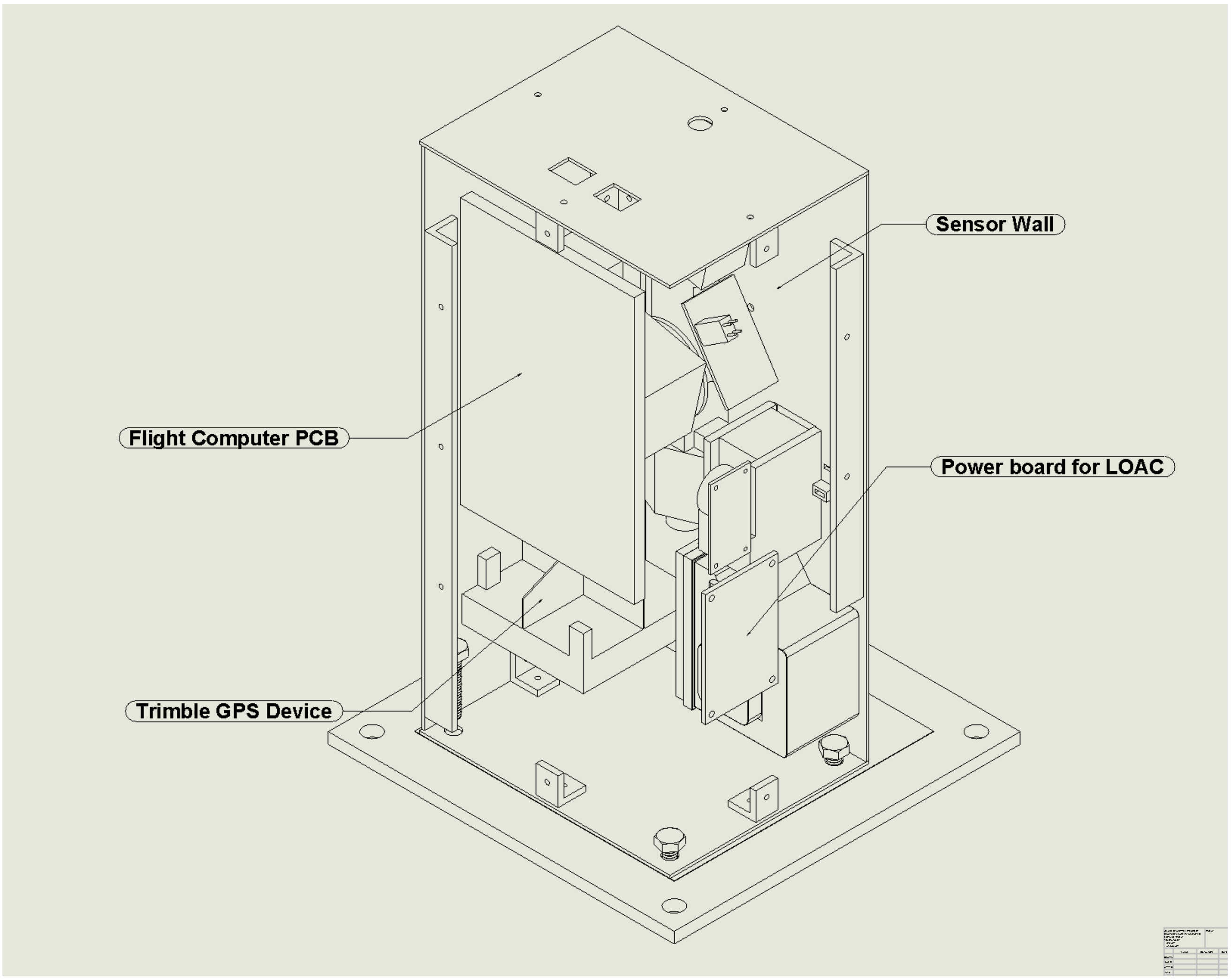


Figure A1. Diagram of assembled payload with invisible top and side walls.

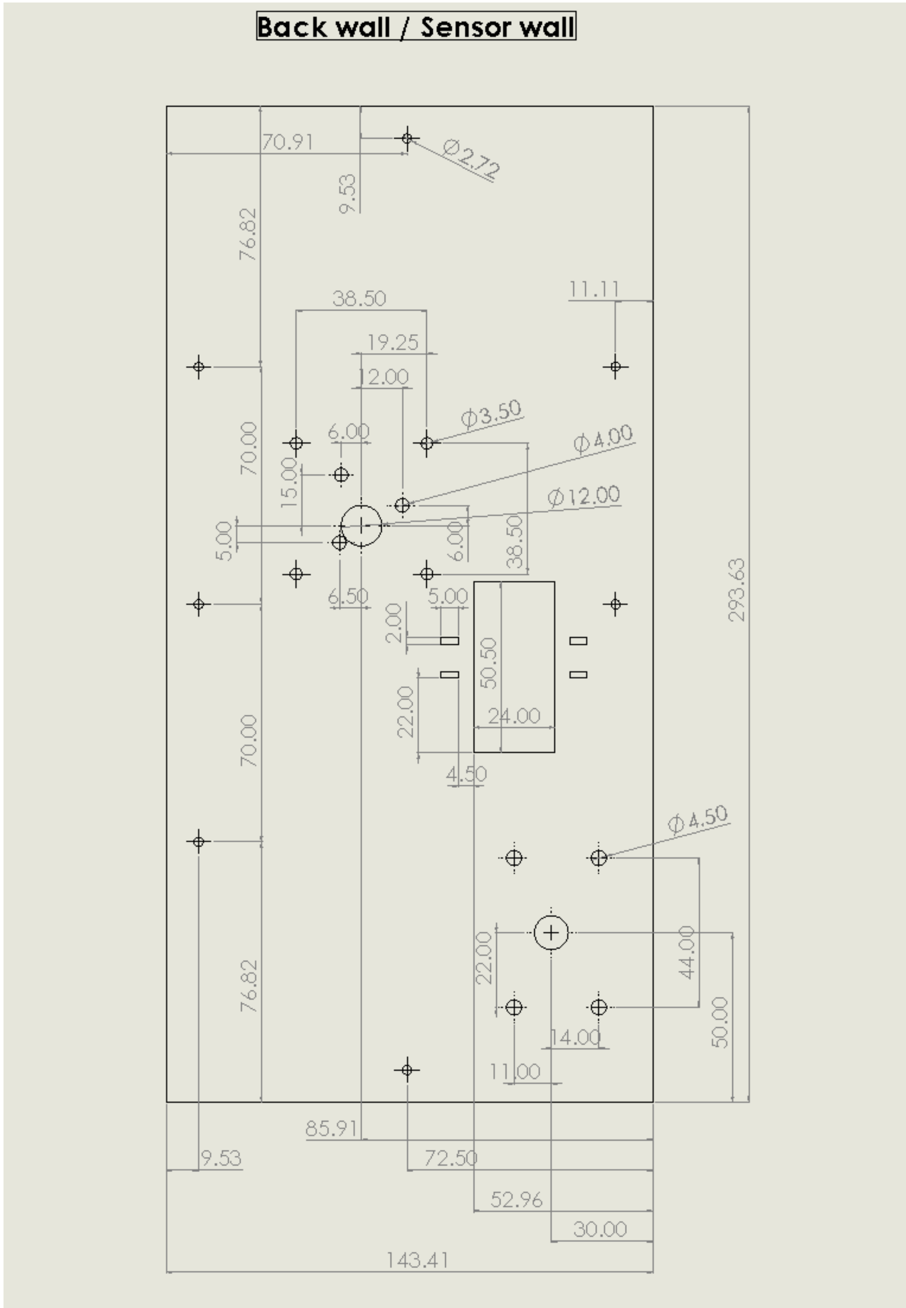


Figure A2. Mechanical drawing of back wall.

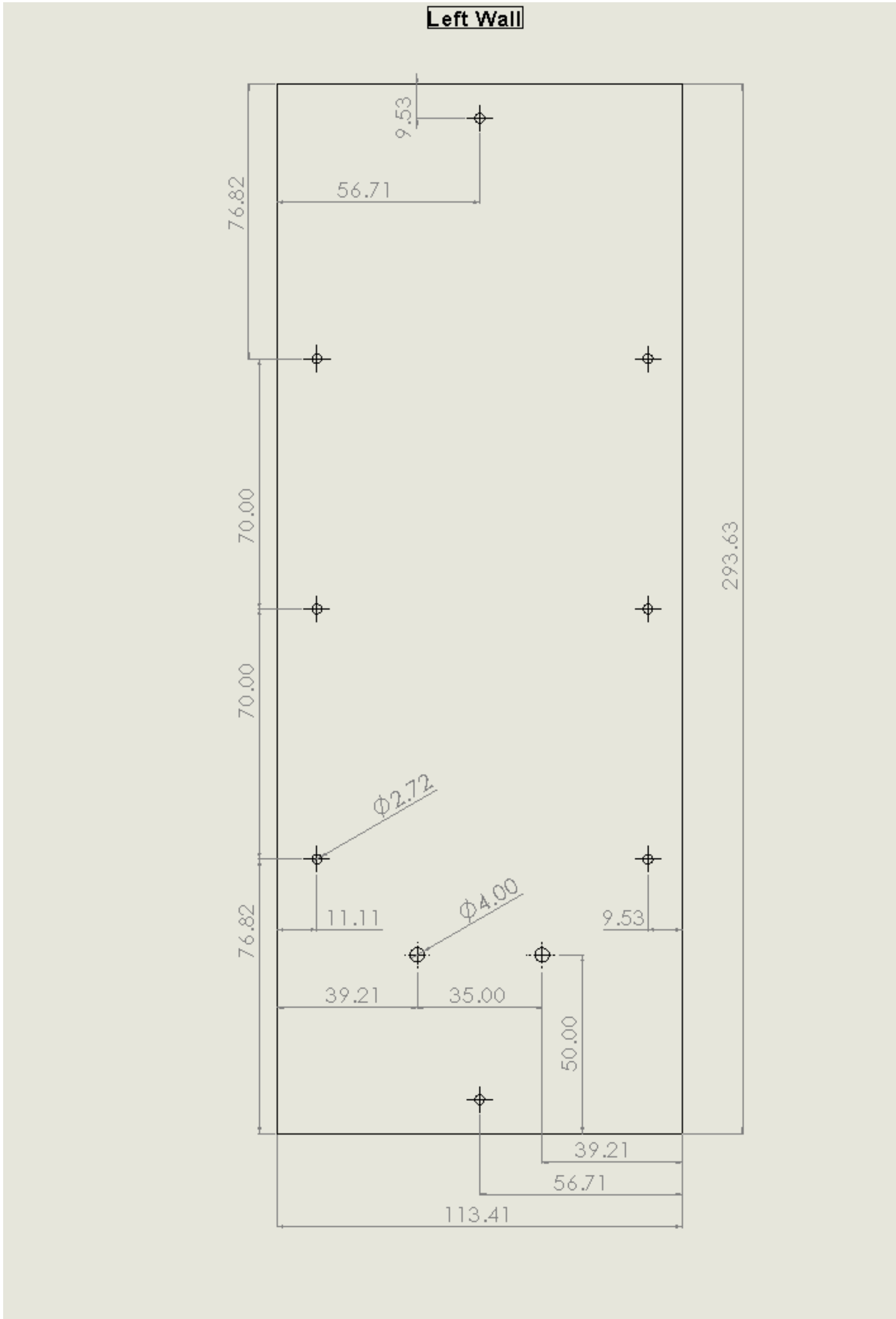


Figure A3. Mechanical drawing of left wall.

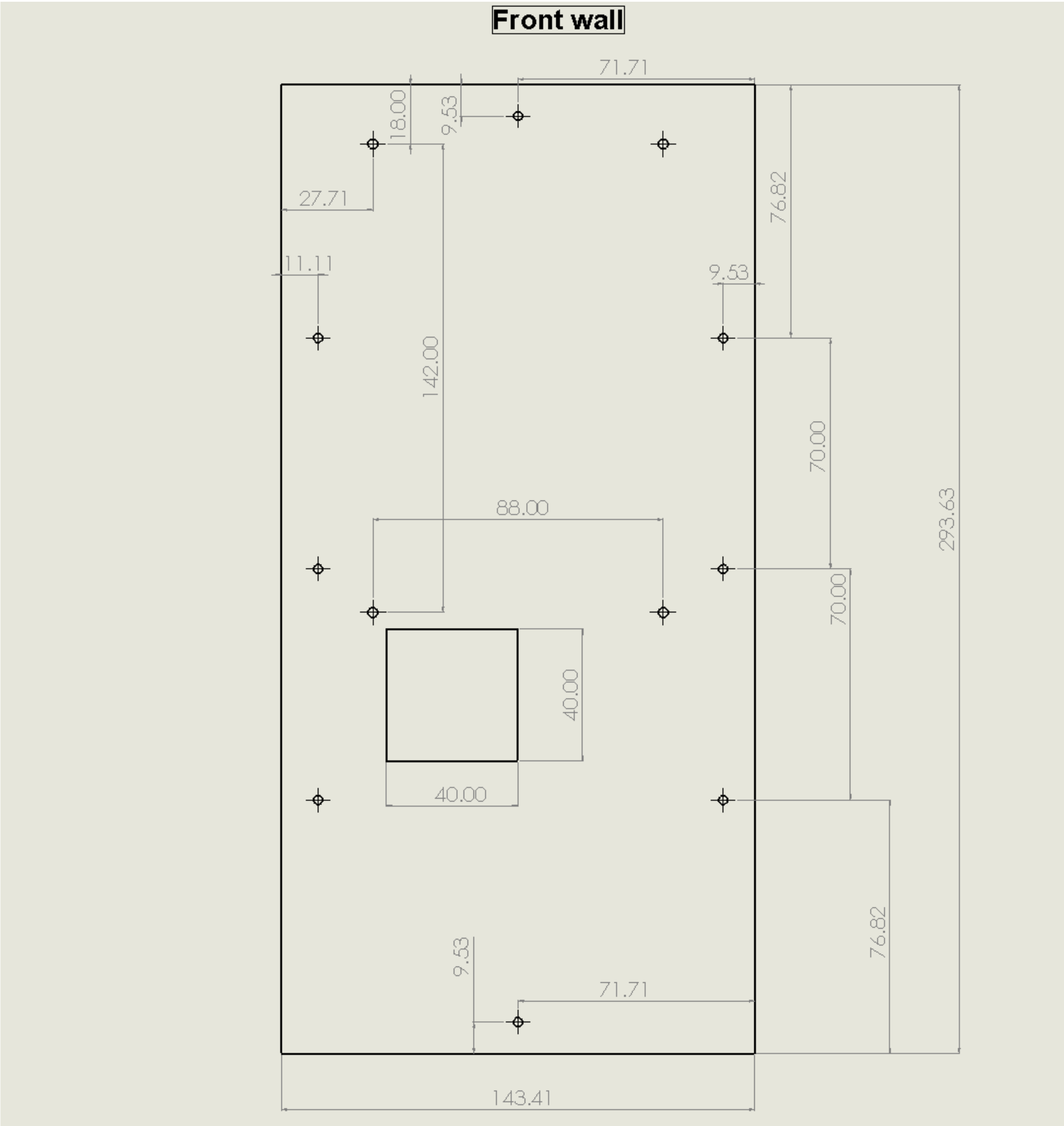


Figure A4. Mechanical drawing of front wall.

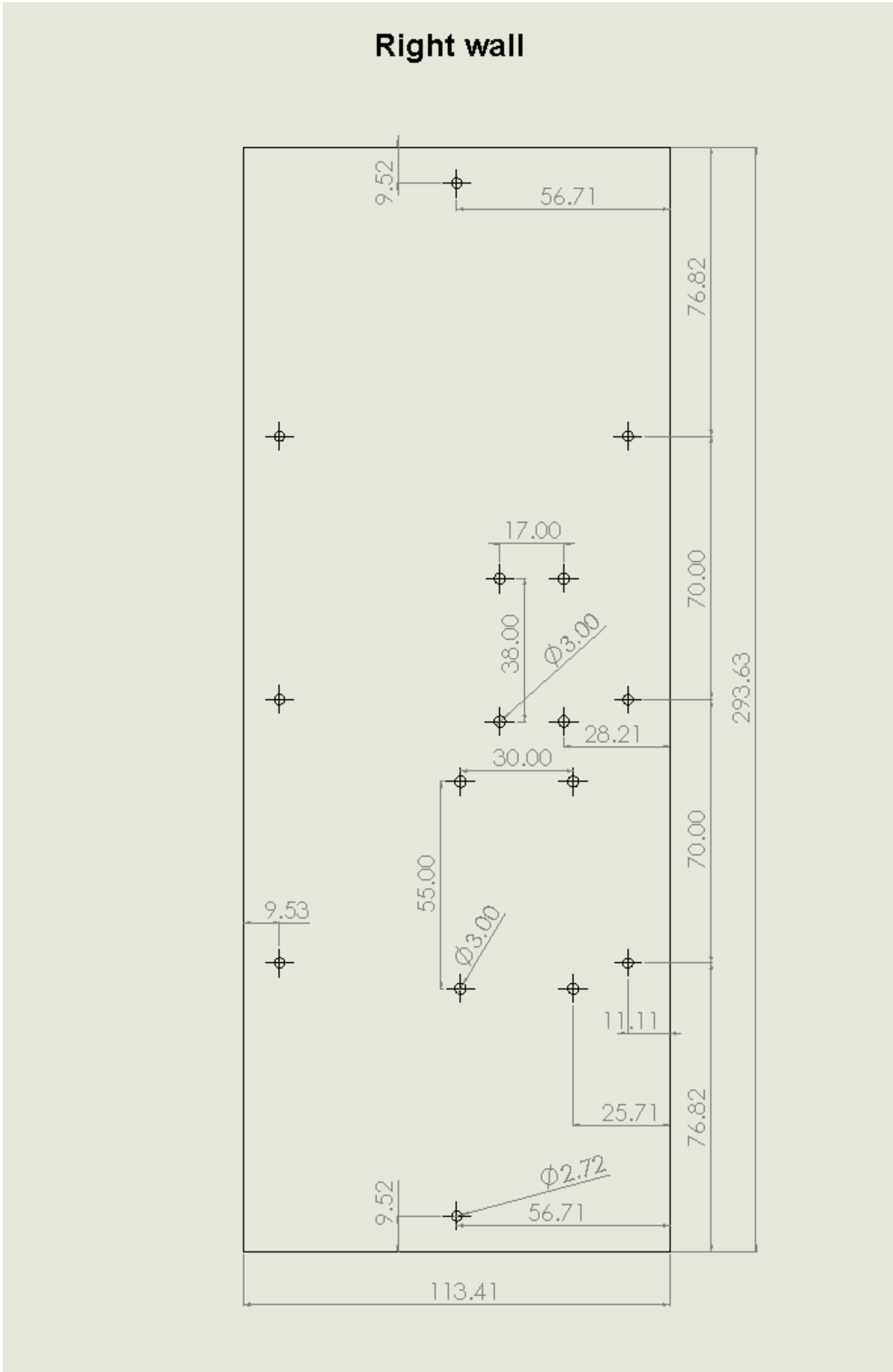


Figure A5. Mechanical drawing of right wall.

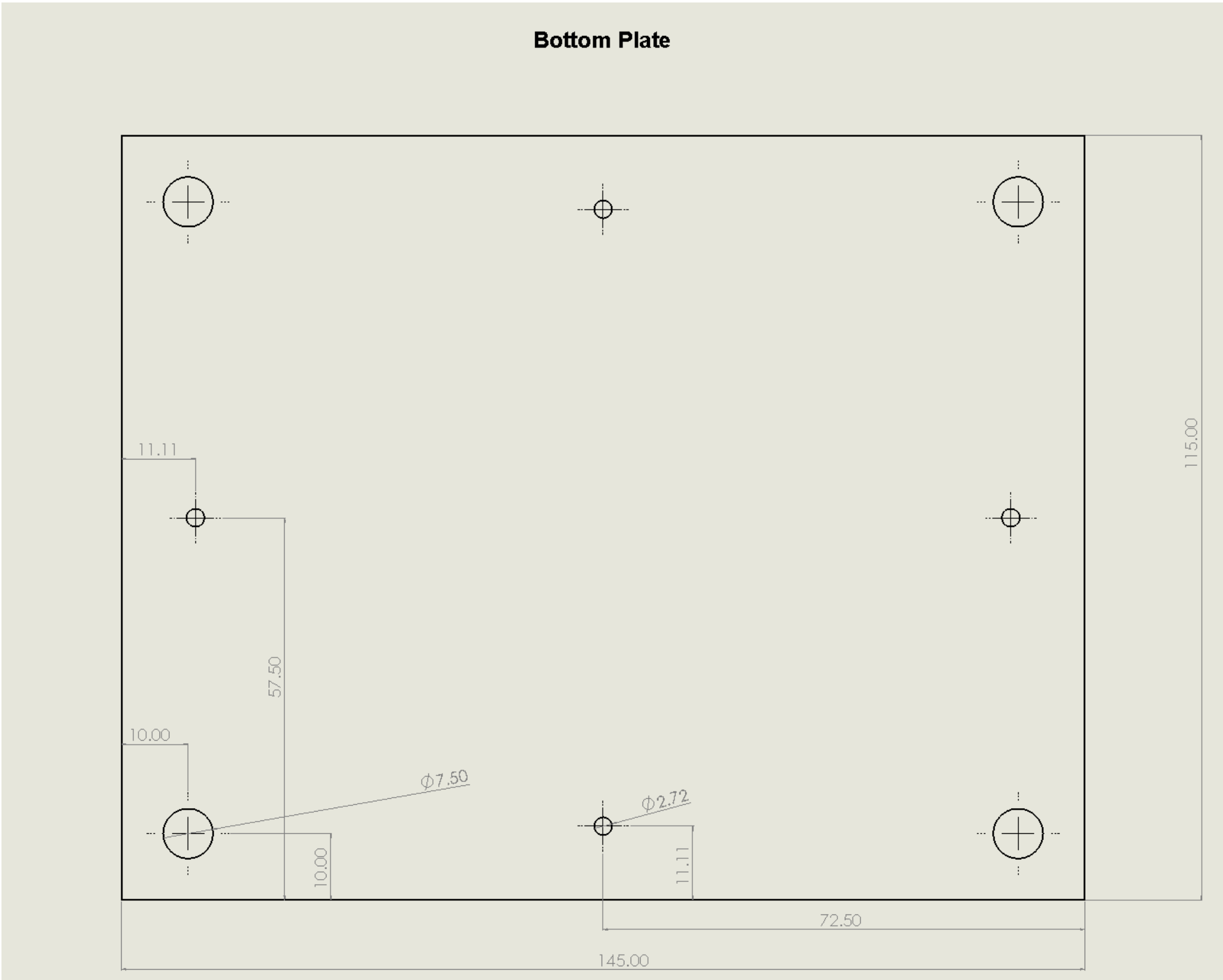


Figure A6. Mechanical drawing of bottom plate.

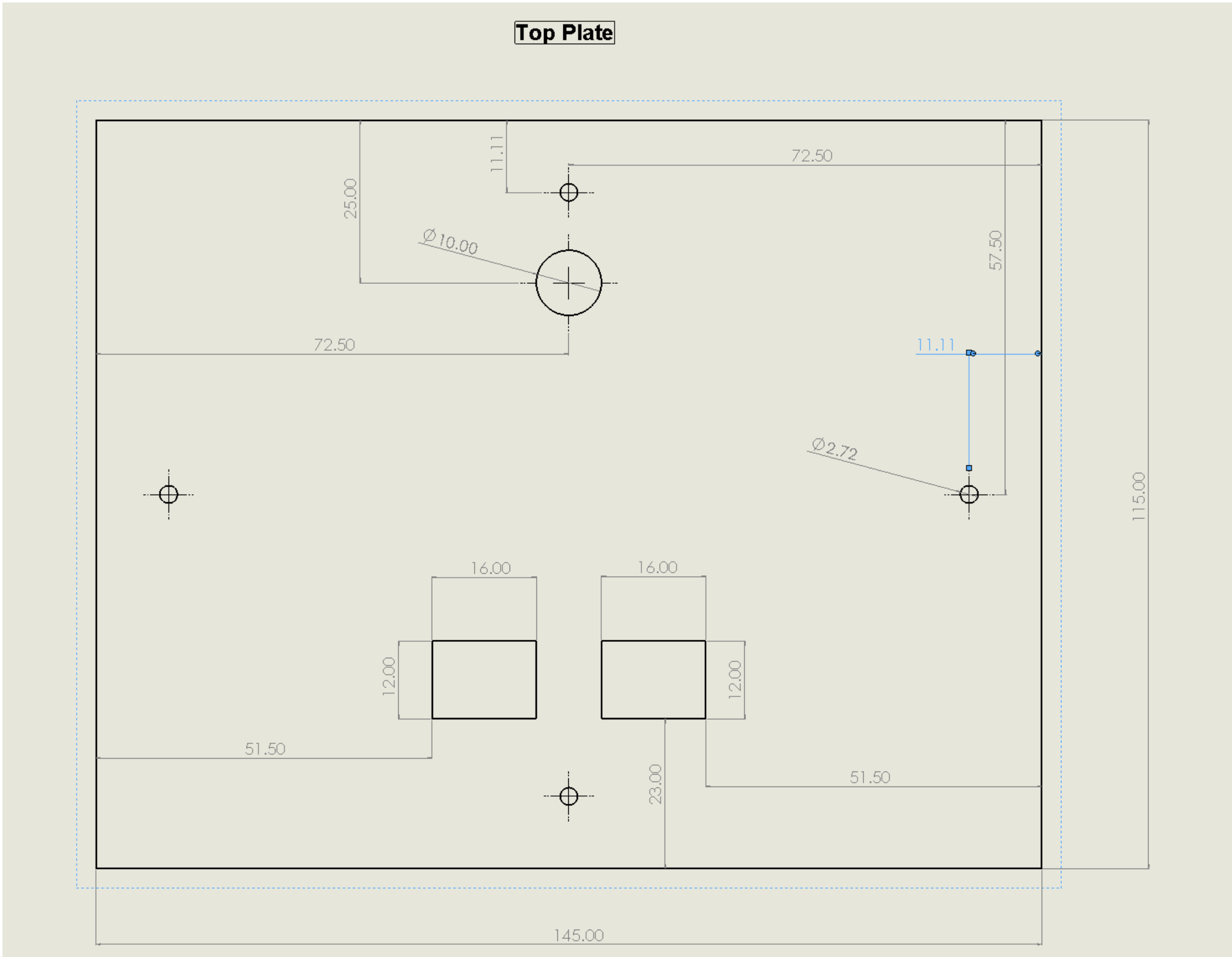


Figure A7. Mechanical drawing of top plate.

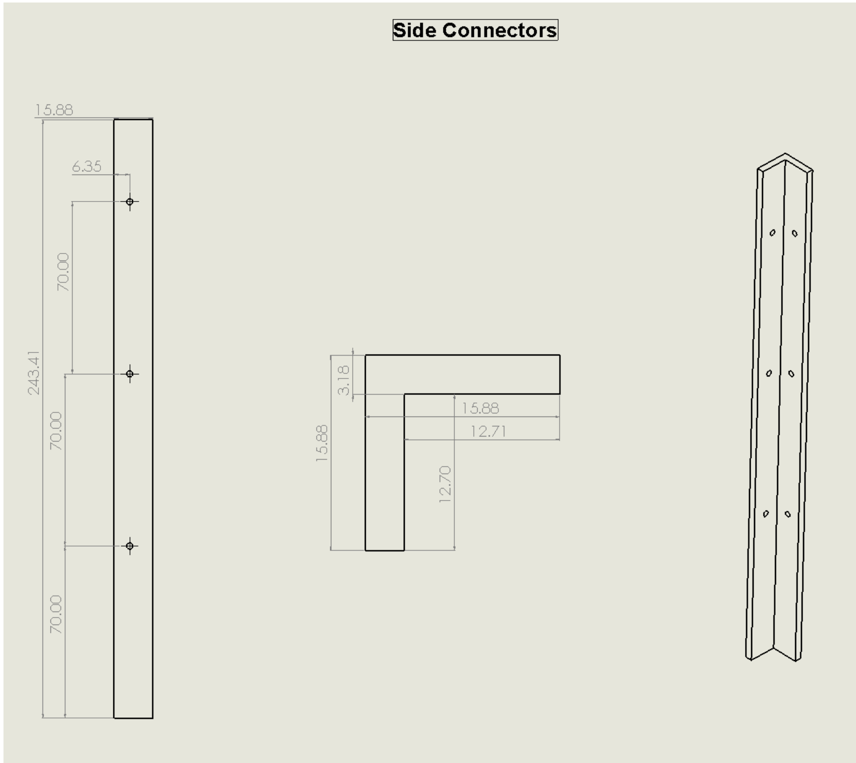


Figure A8. Mechanical drawing of side connectors.

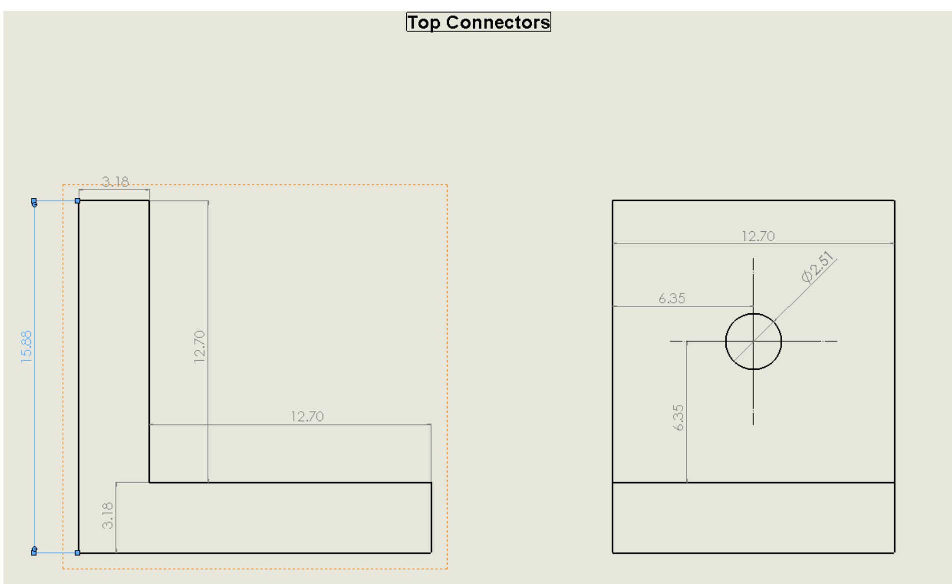


Figure A9. Mechanical drawing of top connectors.

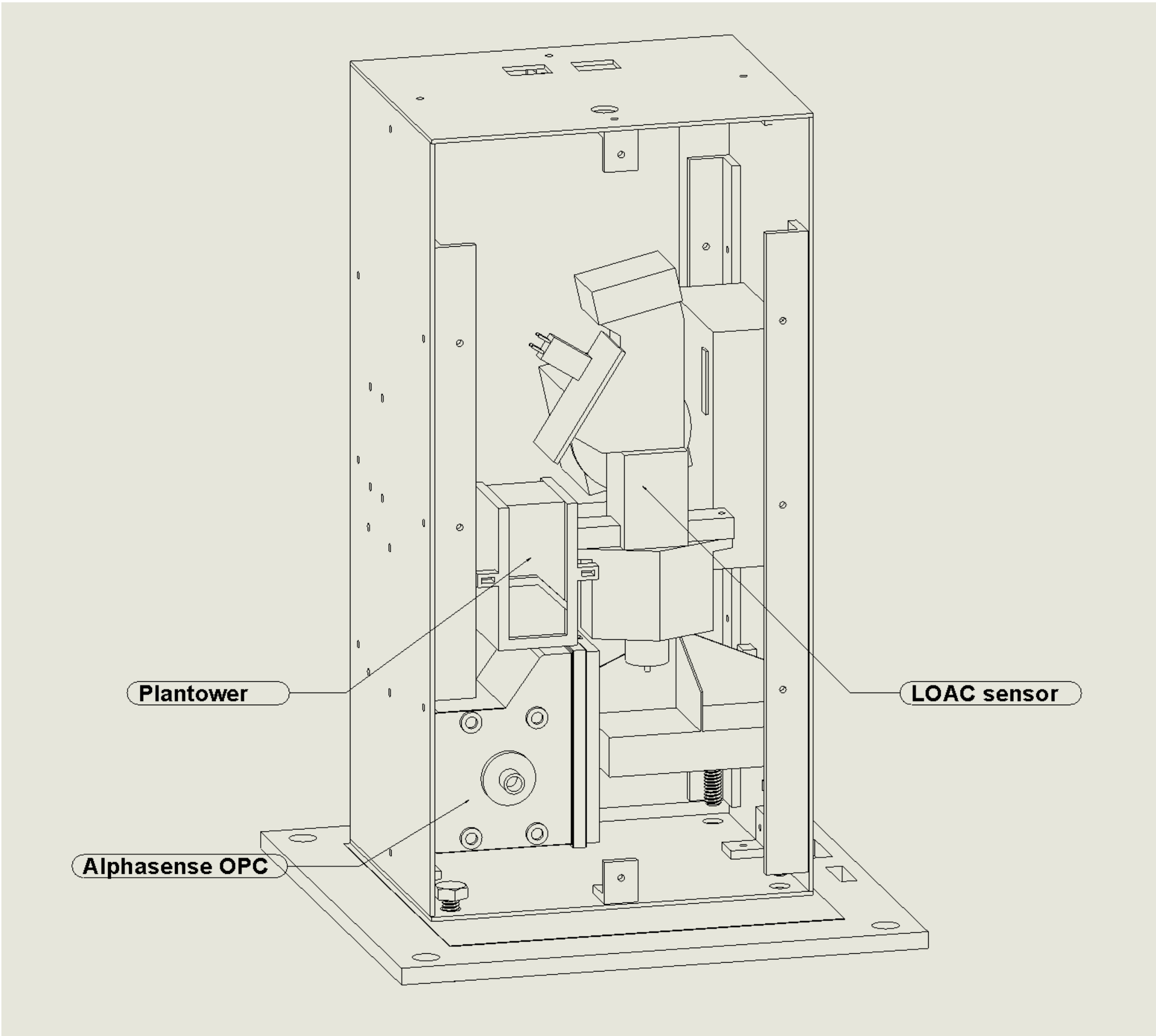


Figure A10. Diagram of assembled payload with sensors showing.

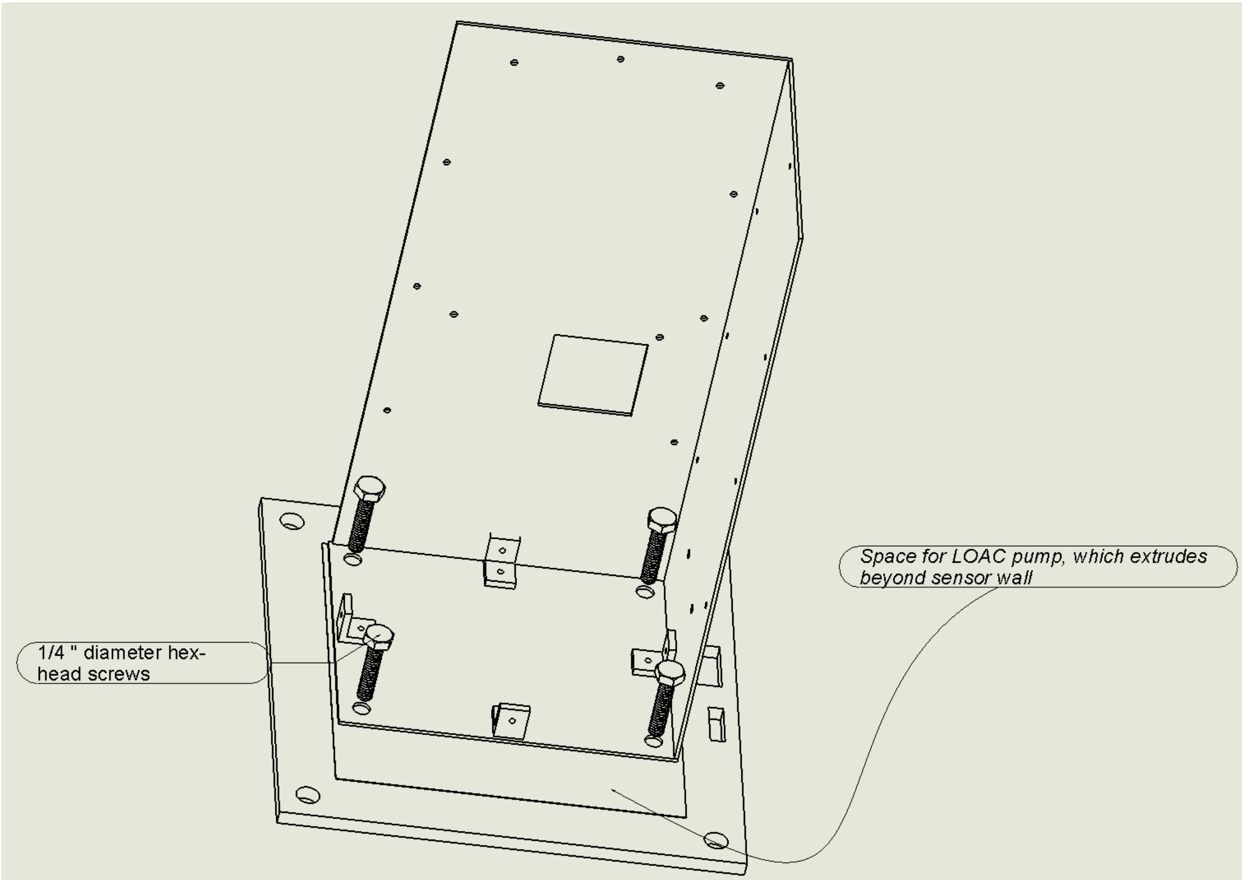
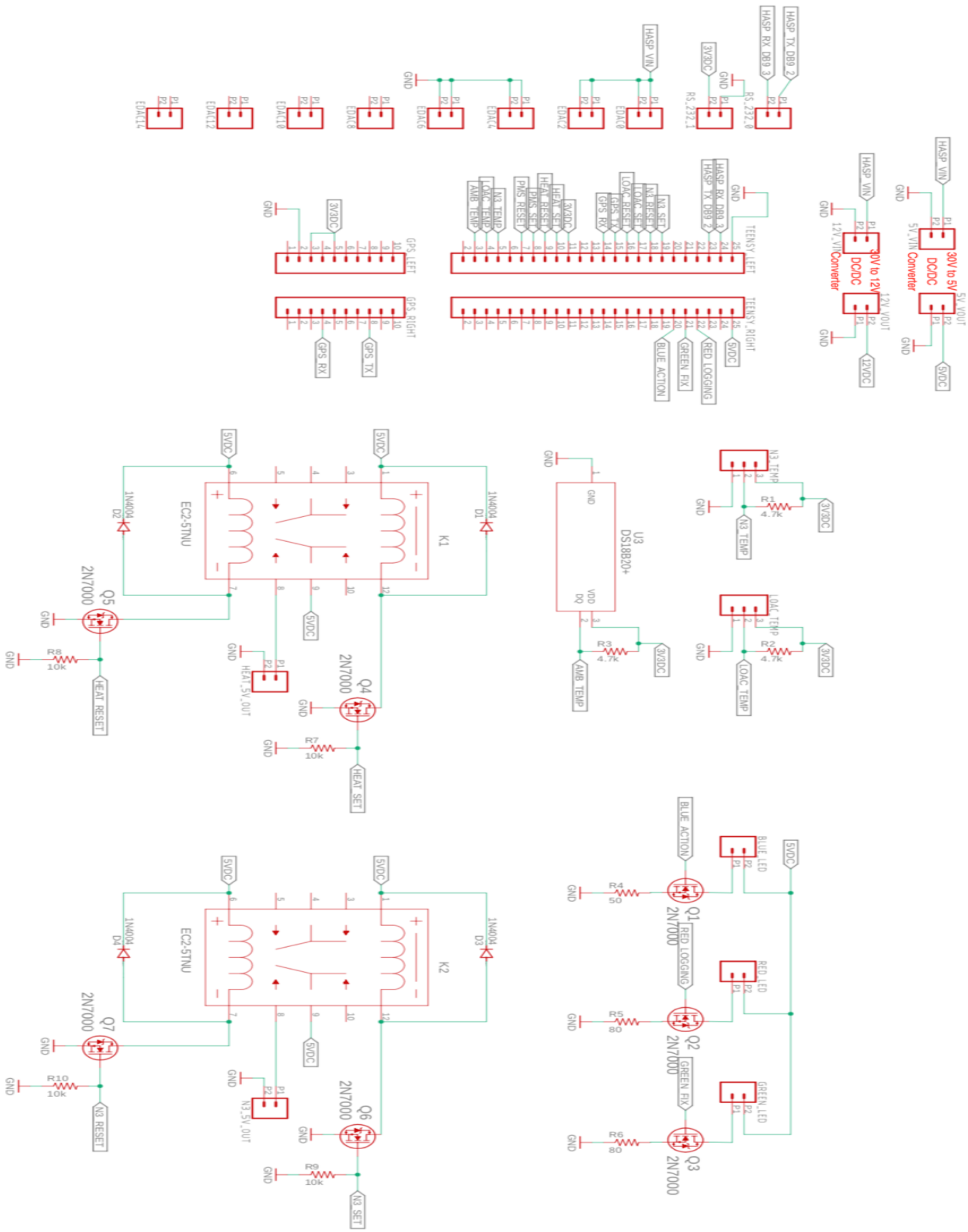
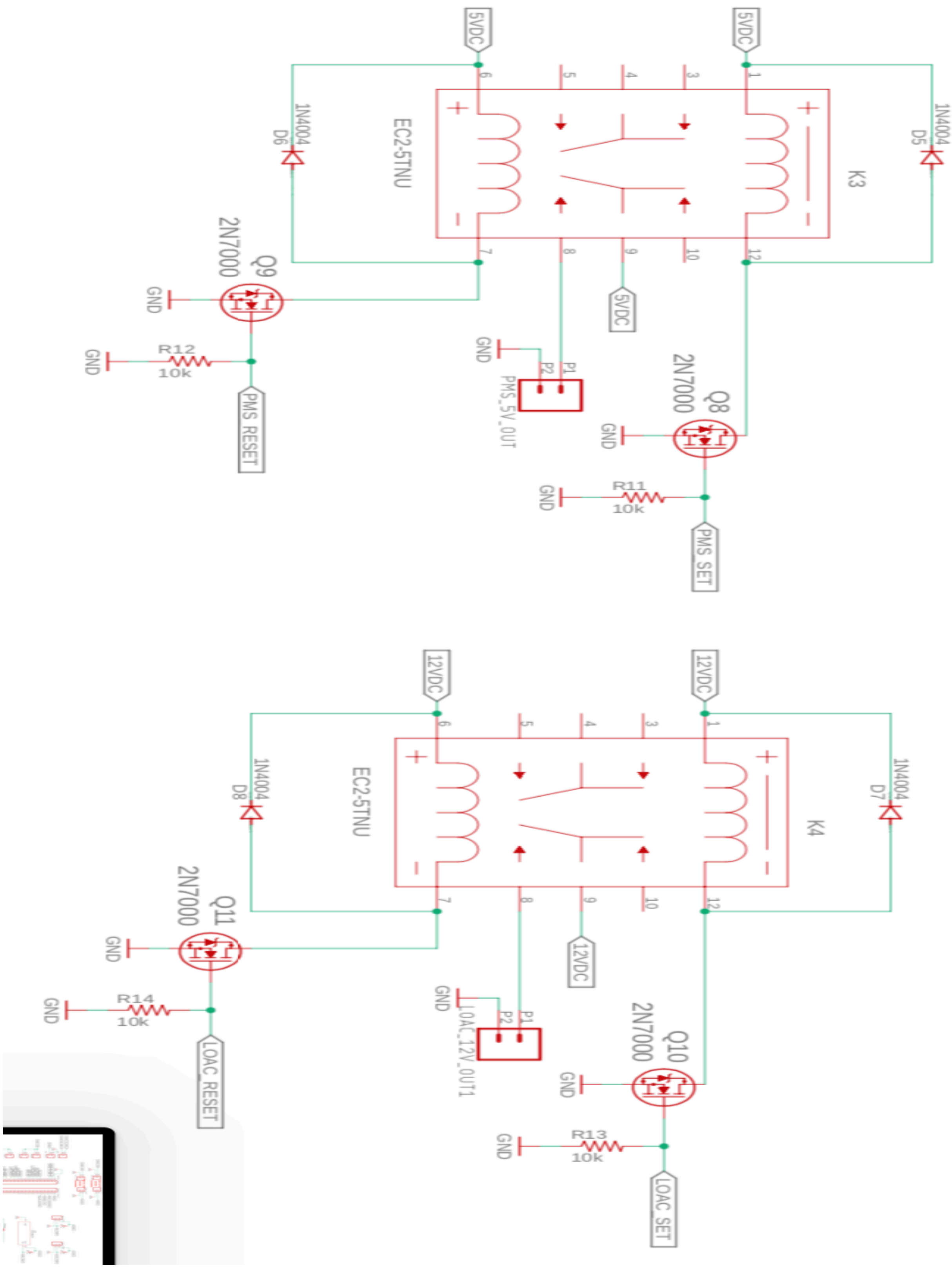


Figure A11. Diagram of assembled payload with mounting style shown. The bottom plate attaches to the HASP plate via 1.25" ATSM A307 14"-20 bolts.

Appendix B- Circuit Diagrams (For clarity, the circuit diagram is split into two parts)




5VDC
EC2-5TNU
K3
1N4004
D6
D5
2N7000
Q9
Q8
R12
10k
R11
10k
GND
PMS_RESET
PMS_SET
PMS_5V_OUT
P1
P2
12VDC
EC2-5TNU
K4
D8
D7
Q11
Q10
R14
10k
R13
10k
LOAC_RESET
LOAC_SET
LOAC_12V_OUT1