HASP Payload Specification and Integration Plan

Payload Title: High Altitude X-Ray Detector Testbed (HAXDT)

Payload Class: [✓ Small] Large (circle one)

Payload ID: 3

Institution: University of Minnesota – Twin Cities

Contact Name: Seth Frick

Contact Phone: 651-494-8923

Contact E-mail: frick100@umn.edu

Submit Date: June 21, 2013

I. Mechanical Specifications:

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

Side panels (4)	0.4992 kg
Bottom plate	0.1381 kg
Top plate	0.1273 kg
Novatel GPS receiver	0.0757 kg
Detector board	0.1573 kg
IMU and mount	0.0508 kg
Detector and housing (estimated)	0.22 kg
Power and interface board (estimated)	0.25 kg
Lead shielding (estimated)	0.90 kg
Total	**2.42 kg**

Table 1. Weight budget and total payload weight.

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

See Appendix for dimensioned mechanical drawings and pictures of major hardware components. Note that these drawings may change slightly as the power and interface board is being rebuilt on a permanent custom circuit board for the 2013 flight. Included are the following:

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…)

No hazardous material being flown.

D. Other relevant mechanical information

The structure walls and detector housing are attached using a size 4-40 socket head cap screw, while the structure is attached to the HASP mounting plate with a 1¼-inch long bolt with a ¼-inch diameter secured by a locknut. Rubber grommets sit between the mounting plate and structure, while washers sit between the nuts and mounting plate.

II. Power Specifications:

A. Measured current draw at 30 VDC

The payload nominally draws 235 mA at 30 VDC as configured. A thermal control system is included to keep the temperature inside the payload above 0° C using a polymide heater, but will be limited to a maximum draw of 200 mA by the hardware interface board. Thus, the total maximum current draw is 435mA. Extensive testing will be completed before integration to ensure the payload never exceeds 500 mA.

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 1 below shows pins A-D from the EDAC 516 connector, which provide the 30 VDC supply to our power protection and regulation circuit as schematically shown in Figure 2. The power is then grounded through pins T, U, W, and X on the EDAC connector. Although a further DC voltage conversion is performed via the daughter board for its peripheral systems, this is not dependent on the power system's first stage as shown in Figure 2.

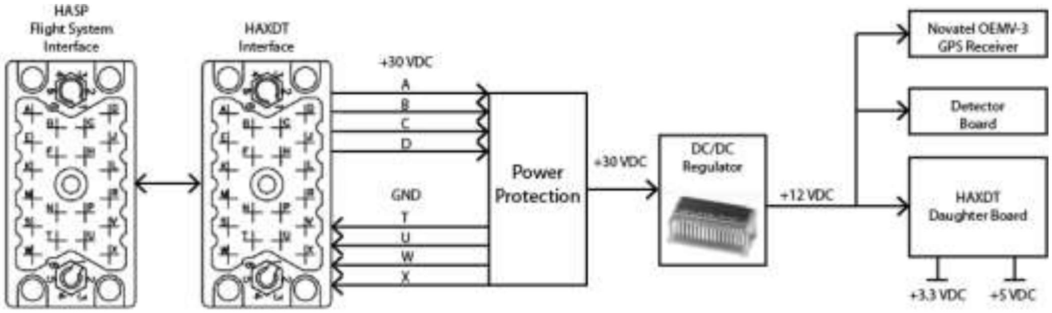

Figure 1. HASP EDAC516 connector interface with the payload power system.

The 30 VDC is converted to 12 VDC using a Texas Instruments PT6886 integrated switching regulator. The payload is isolated from reverse polarity of input voltage and limits the current draw of the circuit to 495mA to prevent in-rush current spikes. A green LED indicates stable 12 V source for the GPS system, flight computer, and x-ray detector.

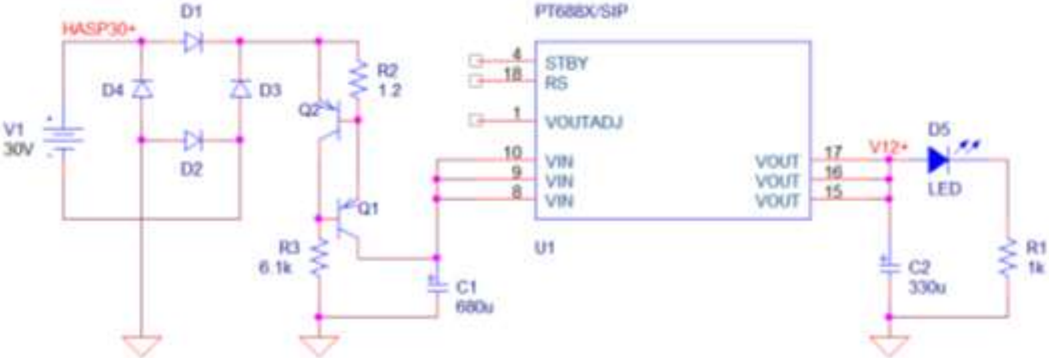

Figure 2. Power regulation and protection circuit. A 12 VDC rail is provided to the payload components by a Texas Instruments PT6886A integrated switching regulator, powered by the 30 VDC from the EDAC 516 connector.

C. Other relevant power information

As mentioned above, a permanent custom power and interface board is under development, but has not been printed as of the submission of this document. This board will replace the setup shown in Figures A14 and A15. The board will be printed, populated, and extensively tested before integration. Note that this board also includes the temperature monitoring and control circuitry. If any issues arise during testing, then the working setup shown in Figures A14 and A15 will be flown instead.

III. Downlink Telemetry Specifications:

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

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

The serial link is connected at 1200 baud using 8 data bits, no parity, and 1 stop bit as described in the HASP Student Payload Interface Manual. The serial downlink traffic from HAXDT will be 440 bps (the 44 byte packet outlined in Table 1 below plus serial framing bits) sent over the 1200 baud connection. This implies we will initiate data transfer once per second, or at a frequency of 1 Hz.

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

Byte	Title	Description
1-2	Header	Indicates beginning of data record
3-10	GPSec	Milliseconds since beginning of GPS week
11-18	X_Pos	Earth-centered Earth-fixed, x coordinate
19-26	Y_Pos	Earth-centered Earth-fixed, y coordinate
27-34	Z_Pos	Earth-centered Earth-fixed, z coordinate
35-42	Ambient_Temp	Temperature of internal chamber of payload
43-44	Footer	Indicates end of complete data record

Table 2. Downlink Data Record

D. Number of analog channels being used: 0

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

F. Number of discrete lines being used: Default power on/off only

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

The default discrete line is used to turn on and off the payload power. This line will also be used to turn the power off and back on if the payload appears to be malfunctioning during flight. No other discrete lines are required.

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.

None.

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.

The payload includes a GPS receiver and antenna. The frequency of the GPS signal is 1.57542 GHz and a bandwidth of ±2 MHz.

F. Other relevant uplink commanding information.

None

V. Integration and Logistics

A. Date and Time of your arrival for integration:

July 29, 2012, Afternoon / Evening (exact time TBD)

B. Approximate amount of time required for integration:

1 hour to test downlink and attach to HASP gondola

C. Name of the integration team leader: Seth Frick / Patrick Doyle

D. Email address of the integration team leader: frick100@umn.edu / doyle174@umn.edu

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

Seth Frick	frick100@umn.edu
Patrick Doyle	doyle174@umn.edu
Haley Rorvick	rorvi008@umn.edu
Alec Forsman	forsm054@umn.edu
Seth Merrifield	merri408@umn.edu
John Jackson	jacks974@umn.edu

F. Define a successful integration of your payload:

All payload systems power on, the flight computer successfully stores and transmits data in a simulated flight environment, and the payload resets and continues to collect data under the same simulated conditions.

GPS and temperature data will be extracted from the downlinked data packets and plotted to examine loss of data during the thermal / vacuum testing. If no data loss occurs, then it is assumed the payload is functioning properly and the integration is a success.

G. List all expected integration steps:

   i. Reprogram GPS receiver for operation above 18km.
   ii. Power on payload and monitor internal system LED’s to verify proper operation.
   iii. Collect data for 15 minutes.
   iv. Disconnect power, remove internal Micro SD card, and review data to ensure proper data collection.
   v. Troubleshoot any issues and repeat steps ii – iv if necessary.
   vi. Weigh payload to ensure it does not exceed 3kg.
   vii. Attach payload to HASP mock-up.
   viii. Provide power and monitor current draw as well as downlink telemetry.
   ix. Troubleshoot any issues and repeat steps i – viii if necessary.
   x. Attach payload to HASP gondola.
   xi. Connect EDAC 516 and RS 232 interfaces to payload
   xii. Perform thermal/vacuum testing
   xiii. Troubleshoot any issues found during thermal/vacuum test
   xiv. Repeat thermal/vacuum test if necessary.
   xv. High-five team members for a job well done.

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

   i. Payload successfully interfaces with HASP gondola
   ii. Payload powers on
   iii. Power can be turned on and off to reset system
   iv. Payload successfully stores data
   v. Payload successfully transmits status packets

vi. Payload operates (remains on, stores, transmits data, and resets) in simulated environment

vii. Status packets are analyzed and no data loss has occurred during operation.

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…):

None anticipated.

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

None required.

Appendix: Dimensioned Mechanical Drawings and Pictures of Major Components

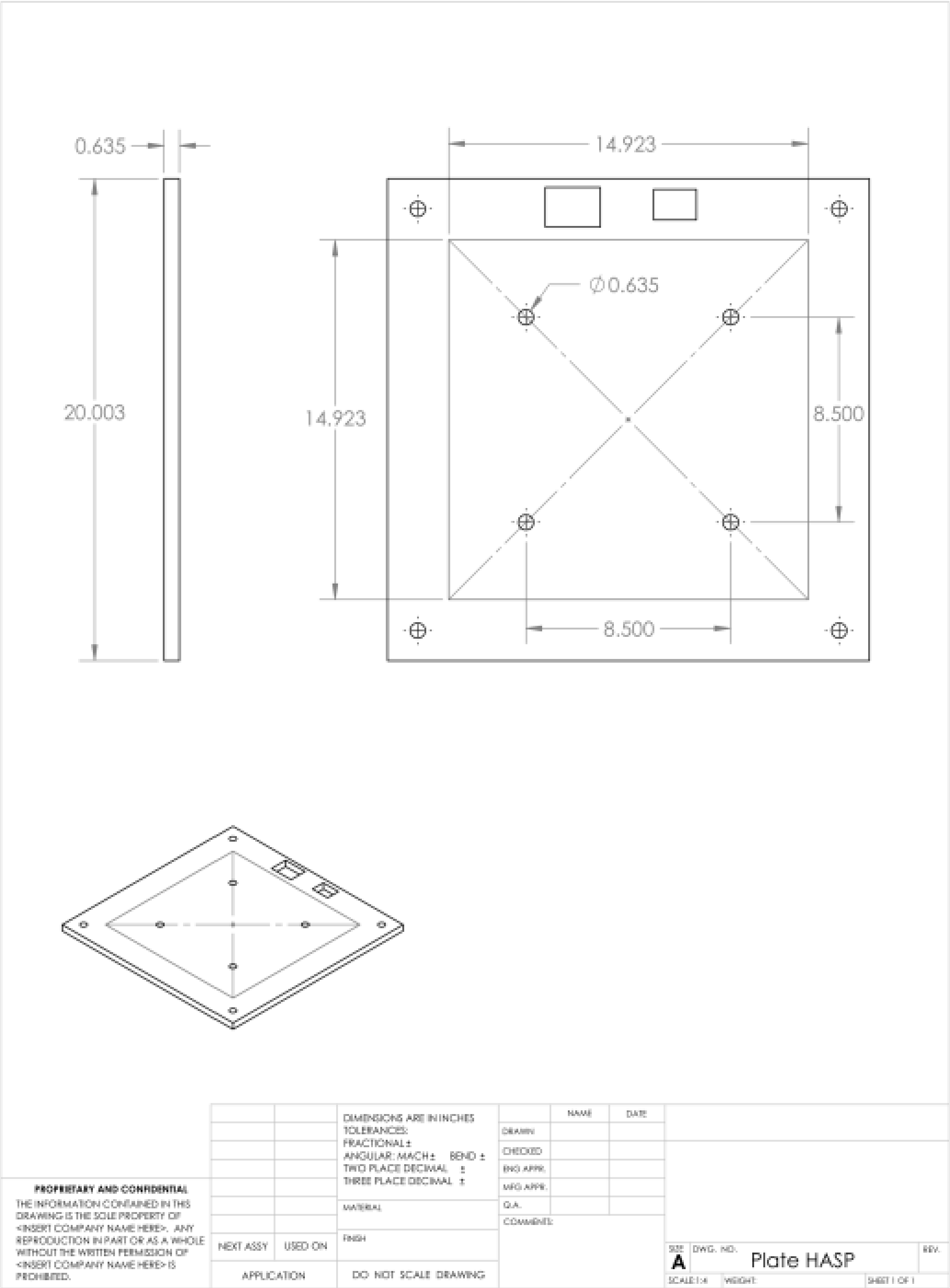

Figure A1. Mechanical drawing showing alterations to HASP mounting plate with dimensions in centimeters.

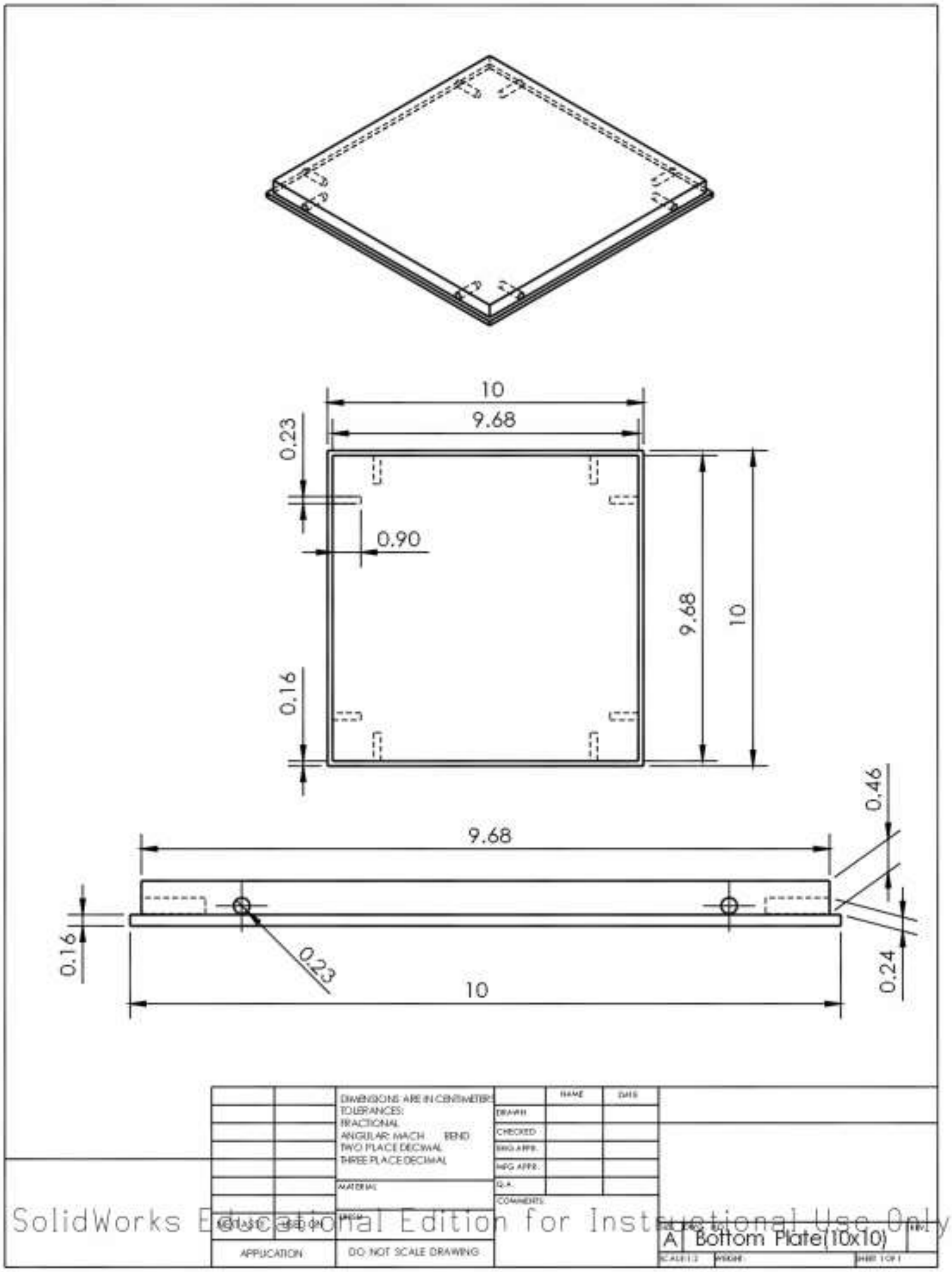

Figure A2. Mechanical drawing of bottom plate of HAXDT structure with dimensions in centimeters. This plate attaches to the HASP mounting plate (Fig. A1).

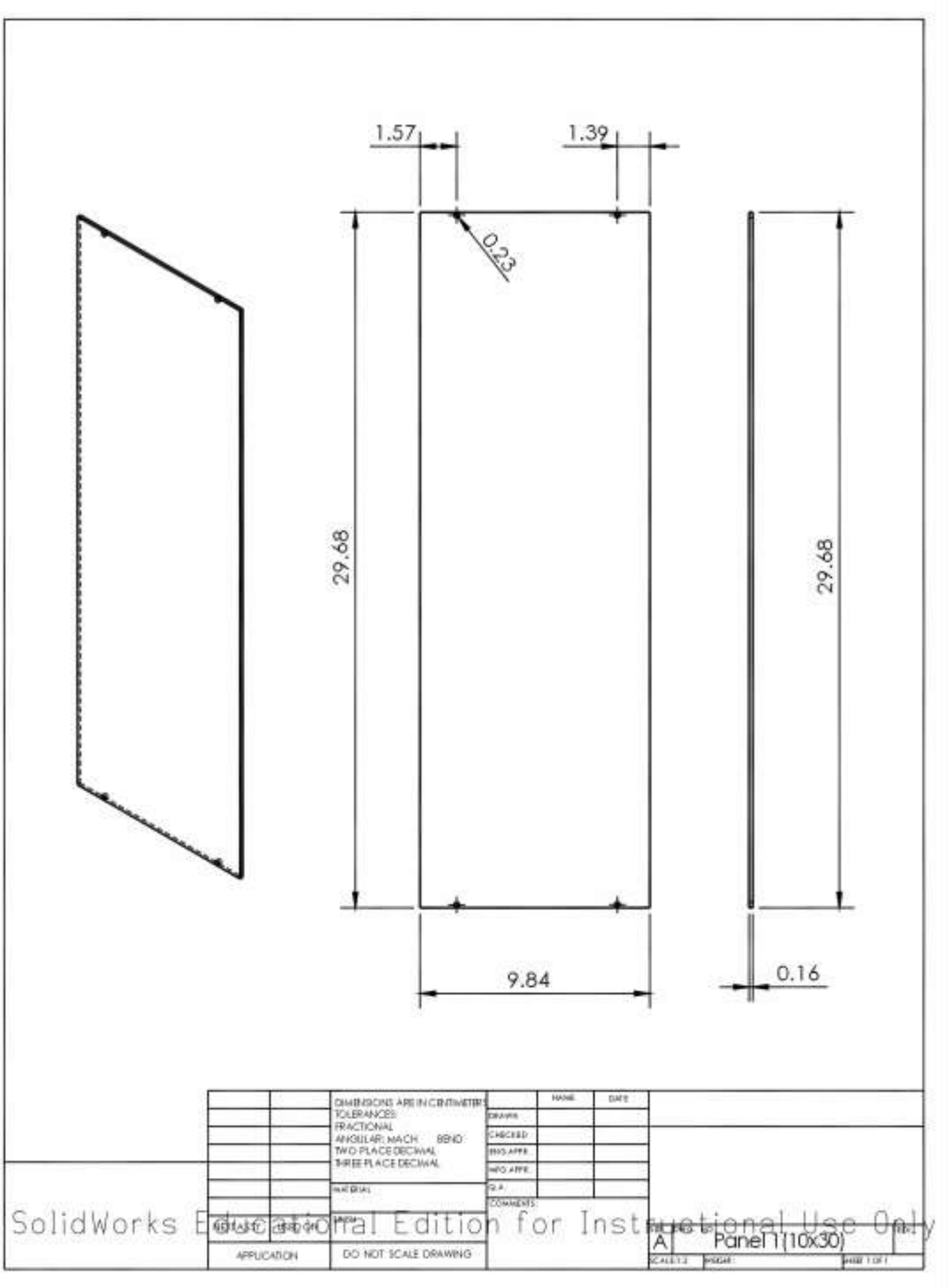

Figure A3. Mechanical drawing of HAXDT structure enclosing wall with dimensions in centimeters. Four of these walls mount to the bottom (Fig. A2) and top (Fig. A4) plates to complete the enclosure.

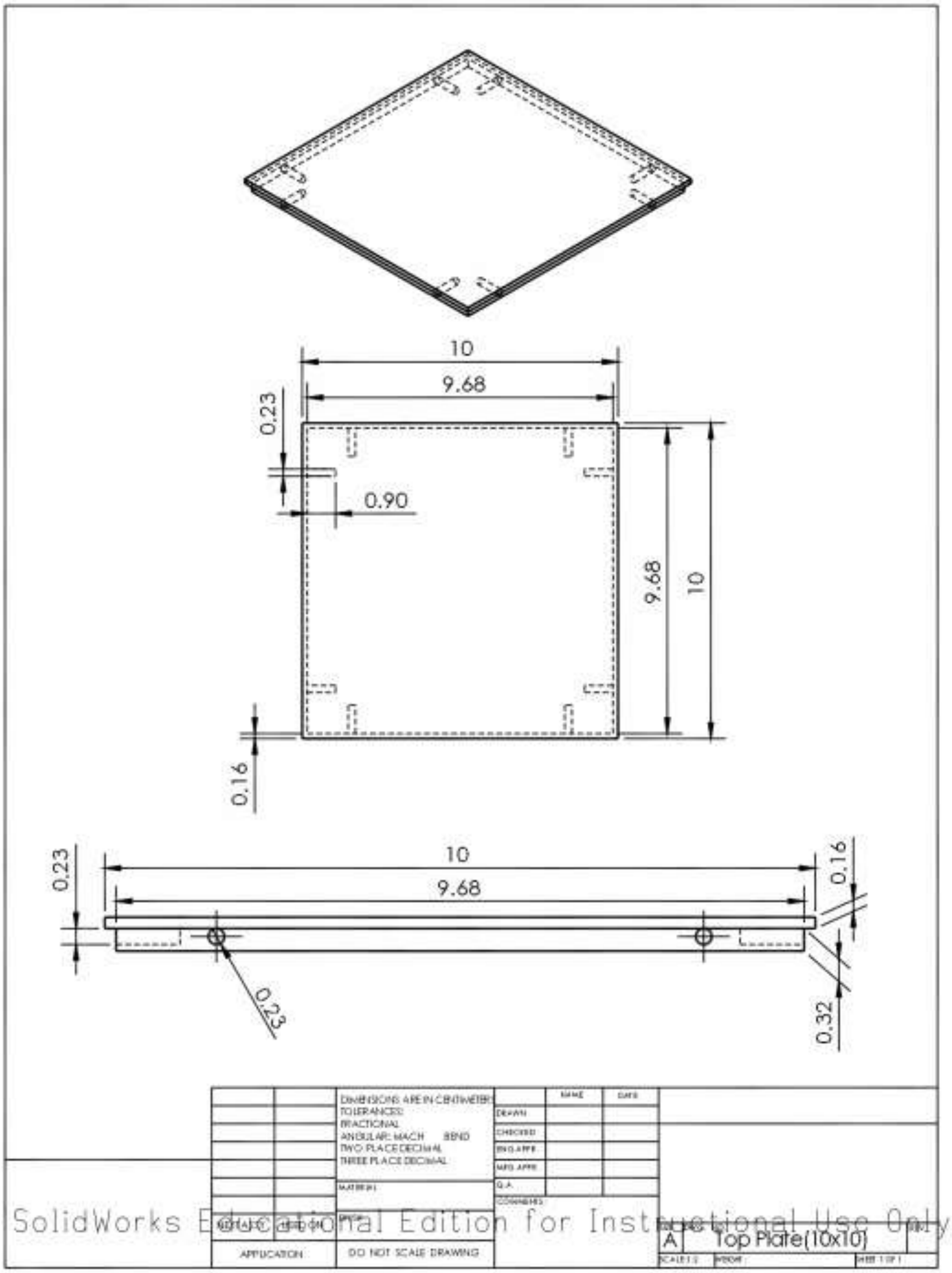

Figure A4. Mechanical drawing of top plate of HAXDT structure with dimensions in centimeters. The detector housing (Fig. A5) and GPS antenna attaches to this plate. Note mounting locations have not yet been determined.

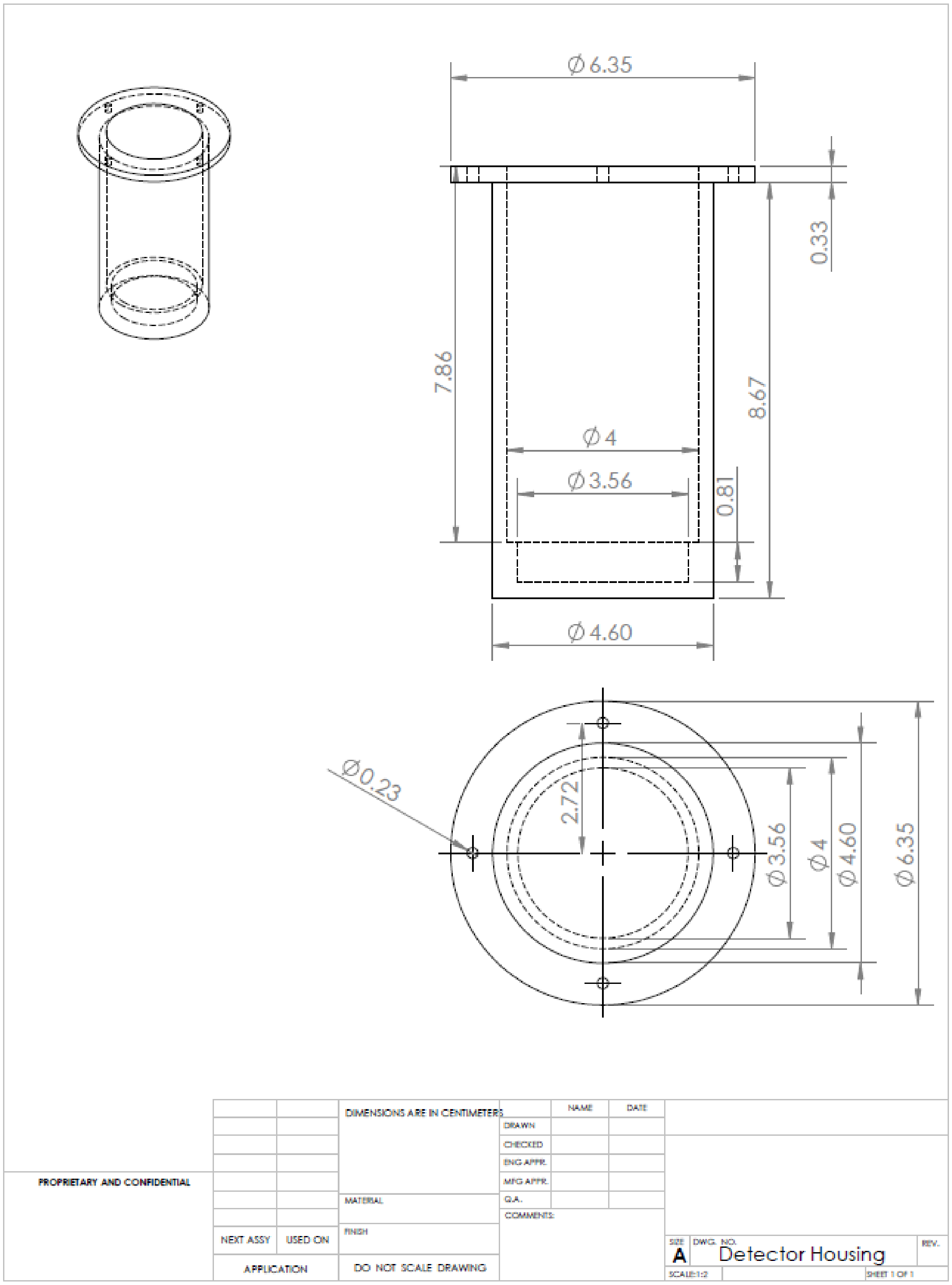

Figure A5. Mechanical drawing of detector housing with dimensions in centimeters. This housing attaches to the top plate (Fig. A4).

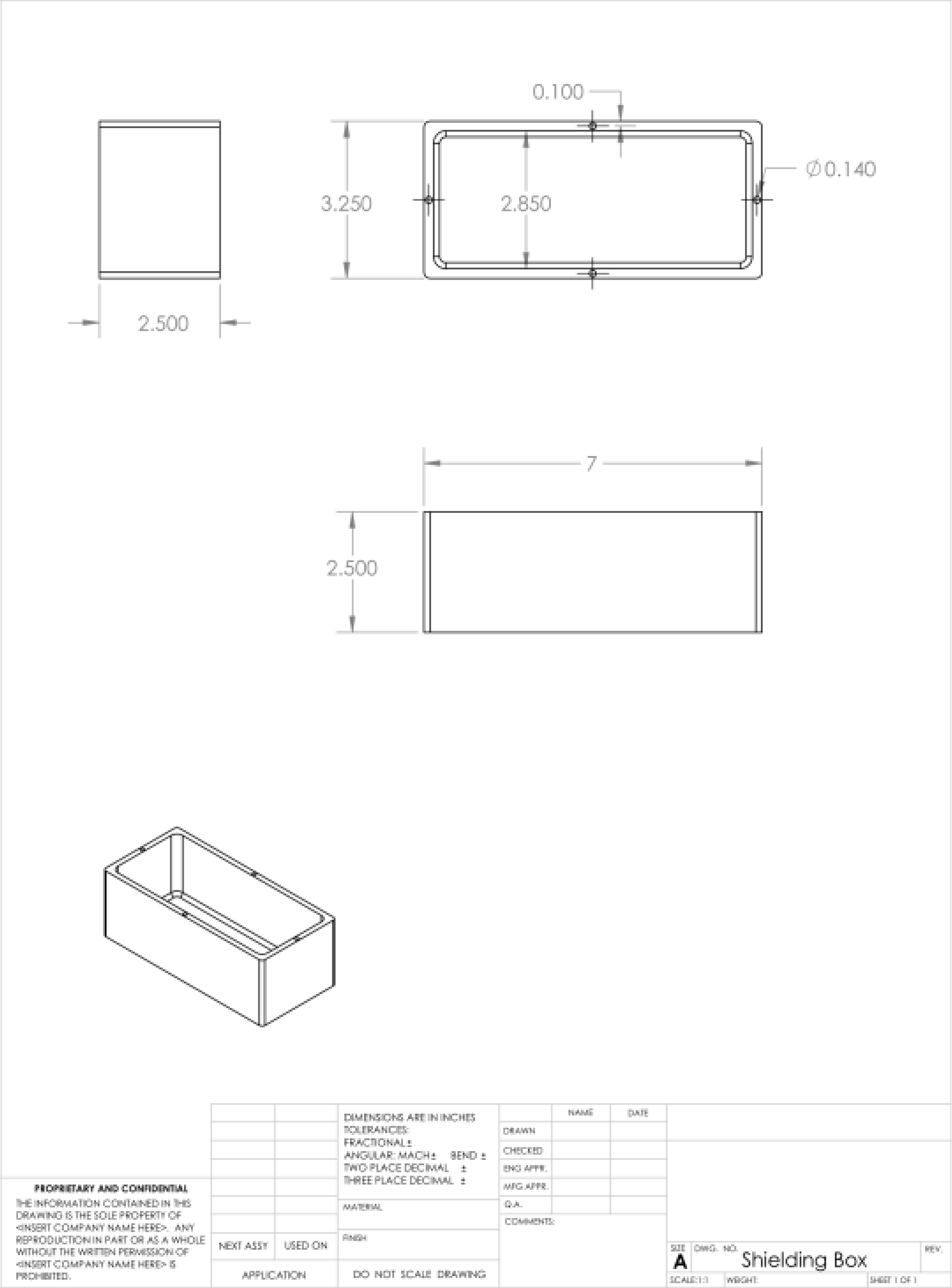

Figure A6. Mechanical drawing of electromagnetic shield for the detector board with dimensions in centimeters. See Figures A7 and A11 for positioning on detector board.

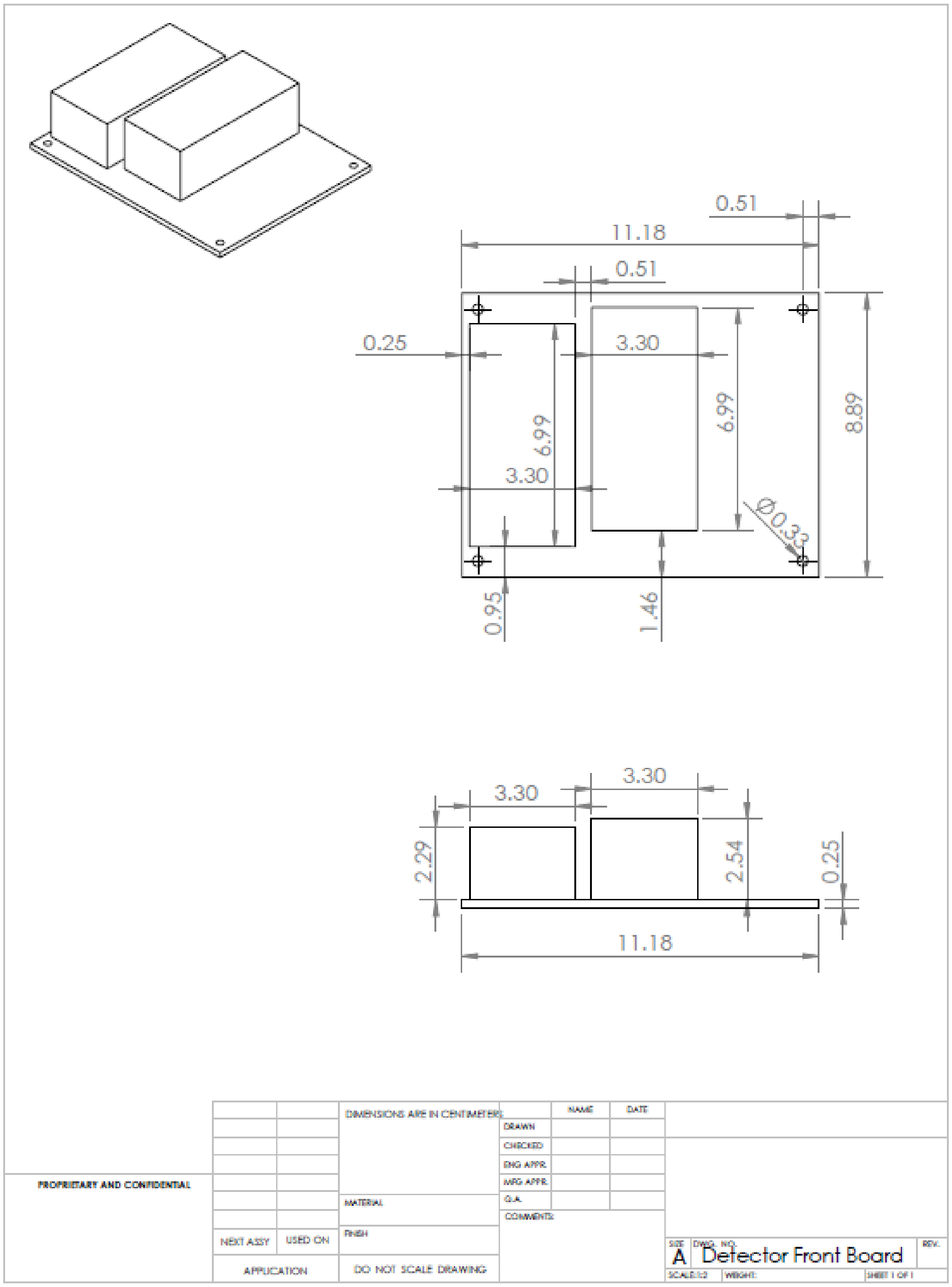

Figure A7. Mechanical drawing of the detector board including the electromagnetic shields with dimensions in centimeters.

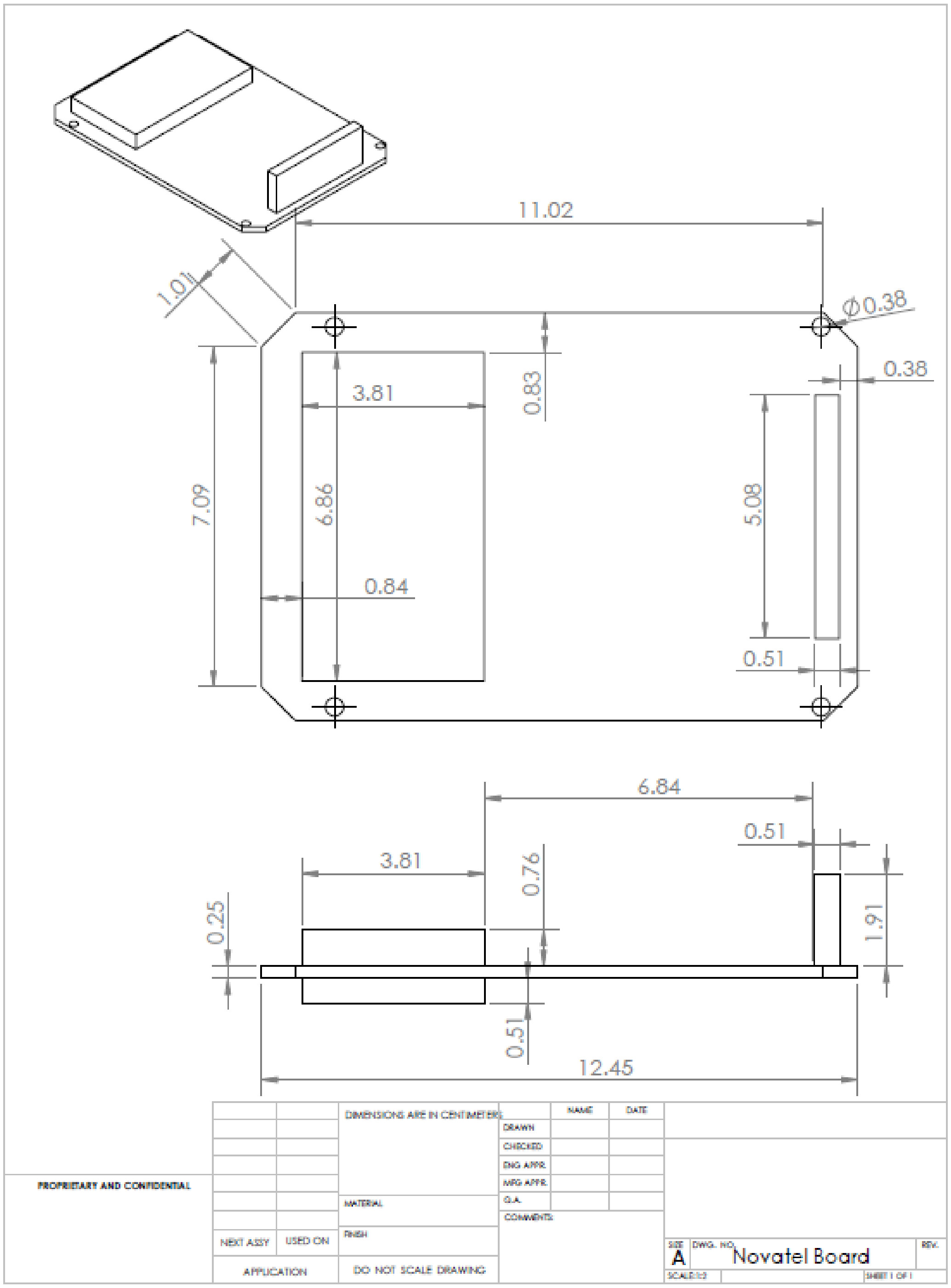

Figure A8. Mechanical drawing of the Novatel GPS board with dimensions in centimeters.

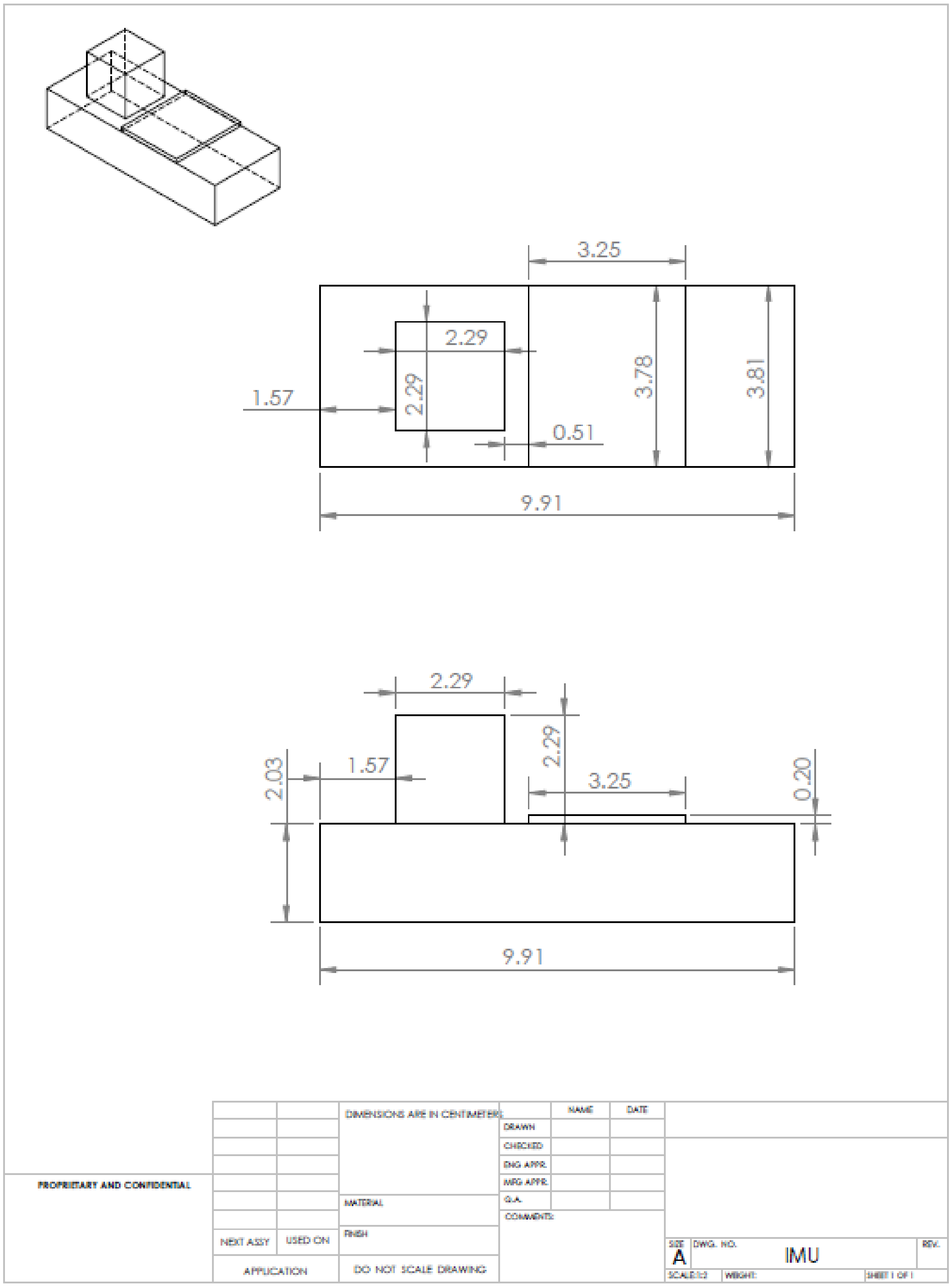

Figure A9. Mechanical drawing of the IMU and its new mounting block with dimensions in centimeters. Note the mounting block is oversized and will be reconfigured to a smaller height less than the 2.03cm as drawn.

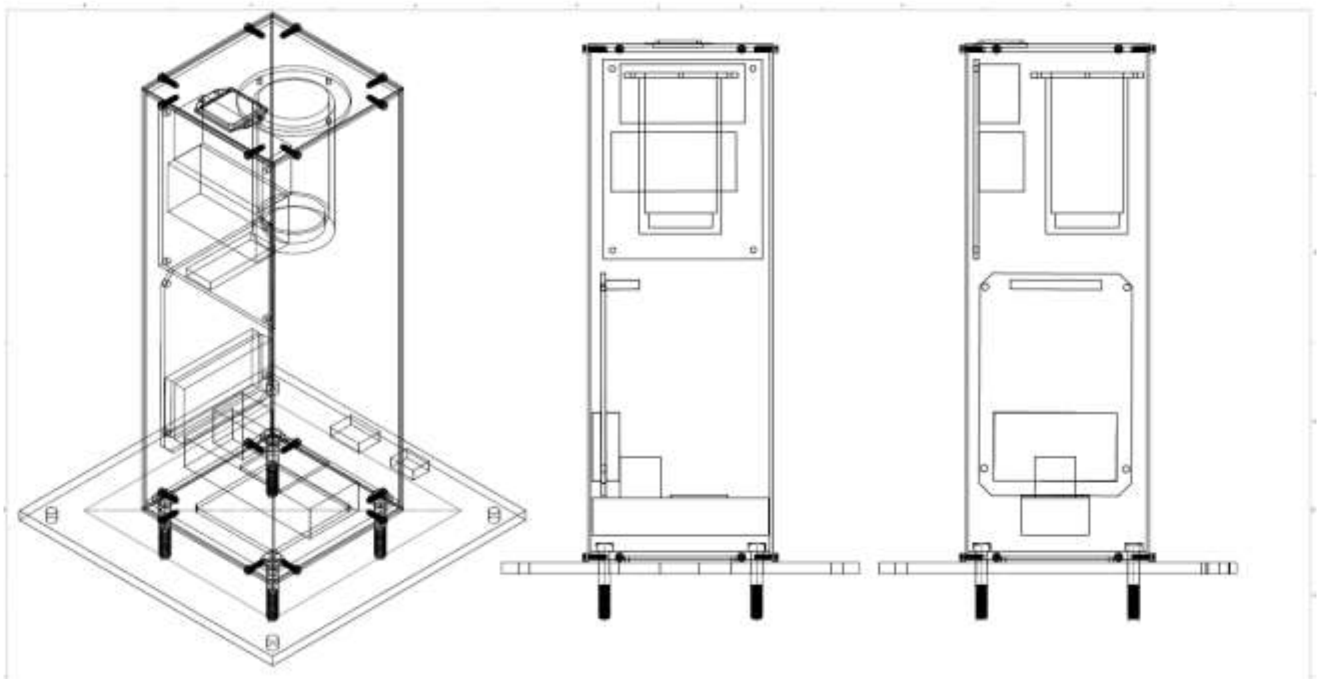

Figure A10. Mechanical drawing of the full payload assembly, including the detector housing, GPS antenna and Novatel board, detector board, and IMU. Not shown are the flight computer, daughter board and the new power and interface board, both of which will be stacked above the Novatel board.

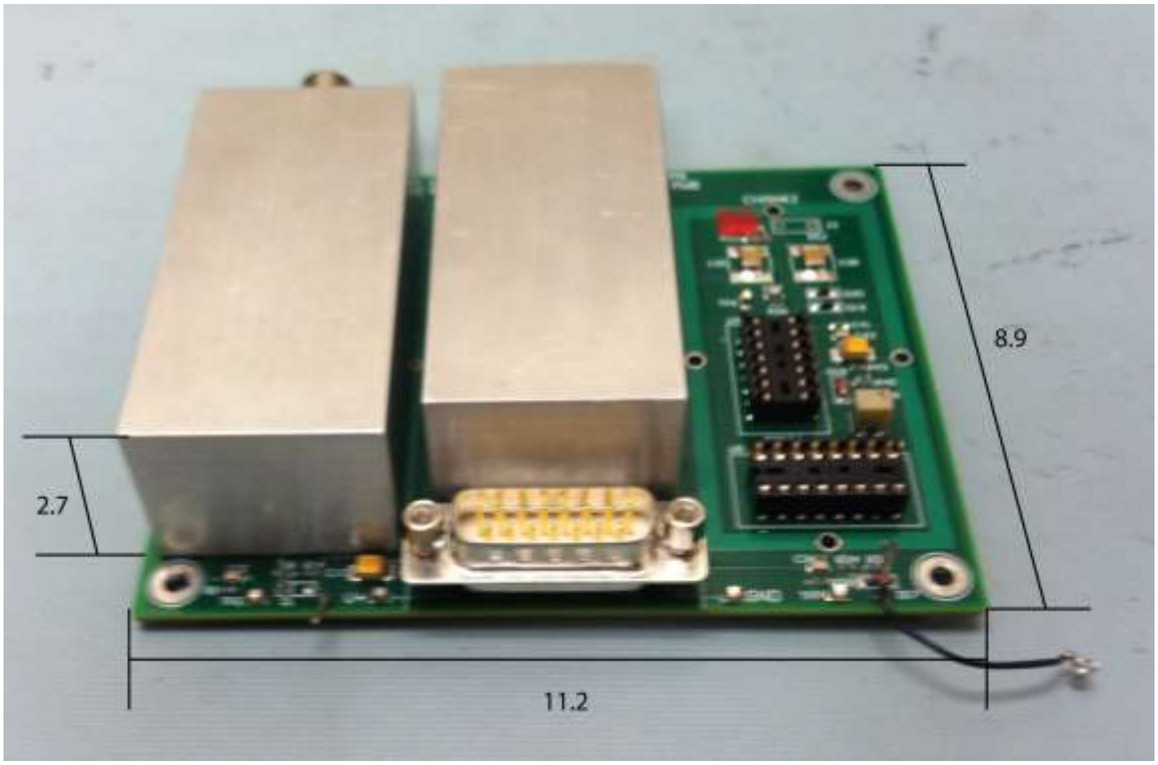

Figure A11. Picture of detector board with dimensions in centimeters.

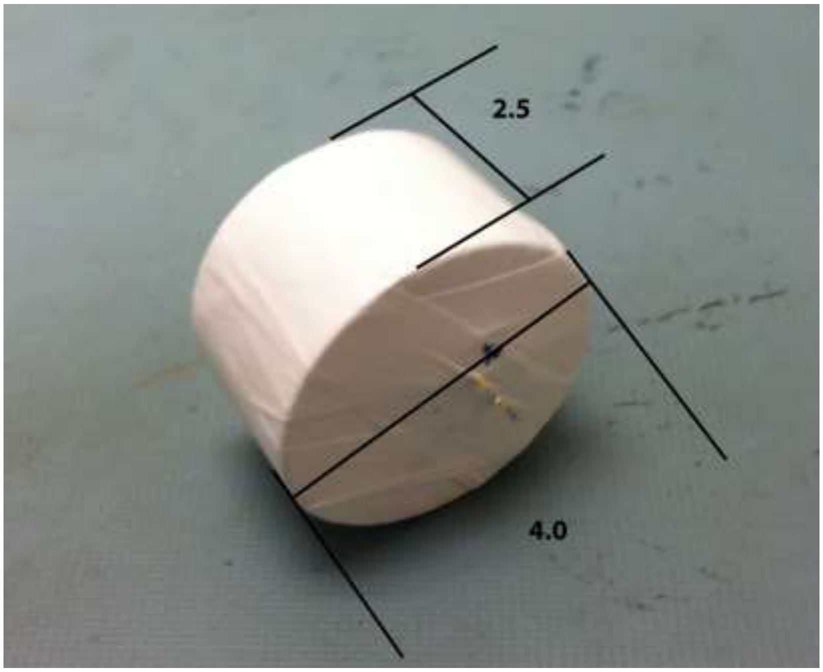

Figure A12. Detector assembly (photodiode affixed to scintillator and wrapped with Teflon tape) with dimensions in centimeters.

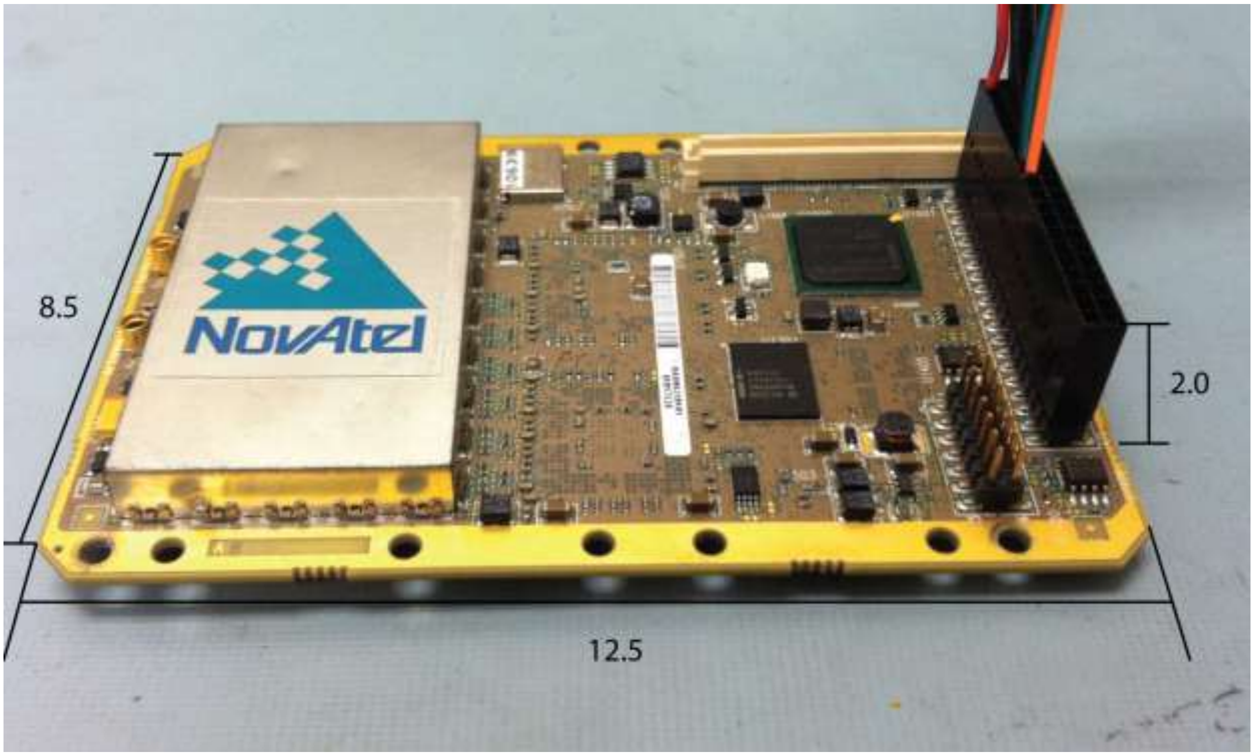

Figure A13. Picture of Novatel GPS receiver and wiring harness with dimensions in centimeters.

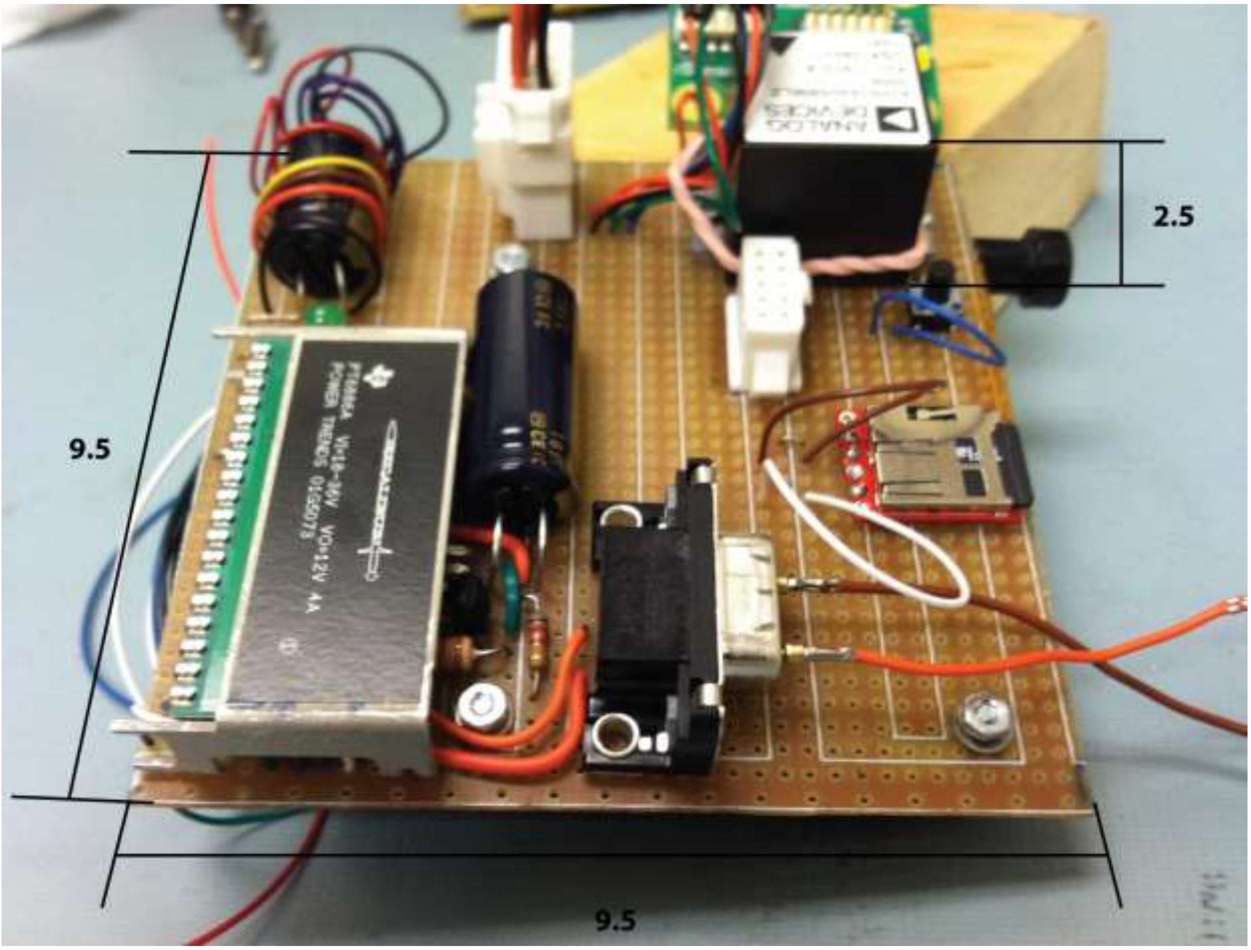

Figure A14. Picture of 2012 power circuit and IMU with dimensions in centimeters. This board serves as the mounting base for the daughter board and flight computer (see Figure A5). This board is being redesigned to a permanent circuit board complete with terminals for attaching sensors.

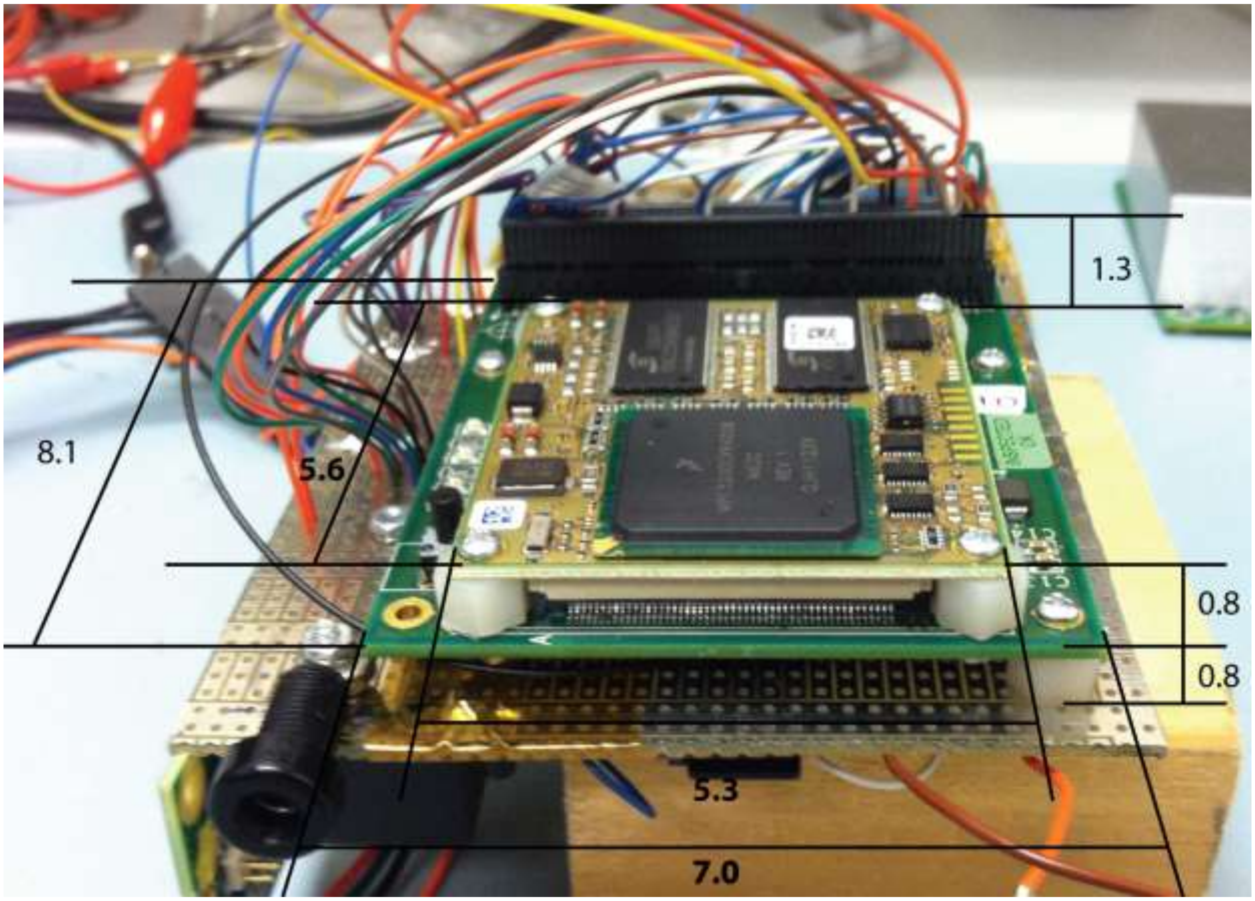

Figure A15. Picture of daughterboard (green board) and flight computer (tan board) stacked and mounted to power circuit with dimensions in centimeters. This assembly will mount to the new power and connection management board.