HASP Payload Specification and Integration Plan

Payload Title: **Student High-Altitude Power Experiments (UA-SHAPE)**

Payload Class: **Small**

Payload ID: **2007-05 (Payload #4)**

Institution: **The University of Alabama**

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Contact E-mail: **mmarcel@ieee.org**

Submit Date: **June 6, 2007**

Notes

The final design of the UA-SHAPE experiment has been modified from the original design due to unanticipated weight variables and safety factors. The original payload was to be equipped with a charging and discharge circuit to examine the effects of charging and discharging energy storage devices at high altitude. Upon further consideration, it was determined that for our first experience with the HASP flight we should incorporate the same concept, but simplify it to make it more safe. Also, integrating a payload that is not complex will afford the students valuable, positive experience and a springboard for future HASP flights.

The new circuitry will only measure discharge characteristics and storage characteristics (as proposed) as opposed to charging, discharging and storage characteristics. The first experiment will pulse discharge a 350F super-capacitor and CR123 Lithium-Ion battery and measure the terminal voltage. This will help determine the equivalent series resistance (ESR) of each device as it operates under pulsed loads at high altitudes. The second experiment will use two different types of super-capacitors and a CR123 lithium battery in open-circuit configuration to determine how much the equivalent parallel resistance (EPR) changes as a function of altitude.

The changes were made as the payload design was built and integrated into the housing to ensure the experiment would provide ample scientific value, while keeping it simple enough for The University of Alabama's first flight on the HASP platform. The data acquisition systems have been prototyped and tested, and the housing has been procured and is in the process of final modification for integration. The data that is provided in this document is based upon true hardware that will be used during the actual flight.

MECHANICAL SPECIFICATIONS

A. Measured weight of the payload.

All payload systems, including the housing have been procured and weighed to ensure accurate data. The major elements were measure with two different scales and the resulting data is shown in Table 1. The UA-SHAPE payload is a small payload, with a 1kg limit; therefore there are approximately 122g available for contingency planning.

Table 1. Measure weight values of major components of UA-SHAPE payload.

Component	Acculab VI-6kg	Acculab VICON
Housing (with 14 screws)	261g	262g
2 populated PC boards	252g	252g
2 Hobo Data Loggers	52g	52g
2 E-film Li-Ion batteries	28g	28g
Elna Dyna-cap (super-cap)	24g	24g
2 Maxwell Boostcaps (super-cap)	110g	110g
Associated wires/misc hardware	100g*	100g*
Insulation	50g*	50g*
TOTAL:	**877g**	**878g**

*indicates NOT a measured value

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

Appendix A of this document is a collection of technical drawings of the UA-SHAPE payload. The first drawing is the approximate size and shape of the major components of the payload. The next drawing shows a technical drawing of the UA-SHAPE housing. The final drawing is a drawing of how the major components will be mounted in the payload. The payload will be mounted to the mounting plate using four angled aluminum pieces mounted to the payload (with two 4-40 screws each) and the mounting plate (with two 6-32 screws each). All screws used will have loc-tite material applied to the threads to ensure the screws will remain tight for the duration of the flight.

C. If you are flying anything potentially hazardous to HASP or the ground crew…

The CR123 lithium-ion batteries are the only elements that may be considered hazardous if they are not maintained properly. The CR123 batteries used in this experiment were chosen to ensure the utmost safety at all times. The team also decided NOT to include the charging circuitry to ensure safety during the flight. Based on the device's datasheet, the device includes internal circuitry to limit the overcharge and dissipation of the battery to ensure the battery remains safe at all times. A risk-assessment was performed when choosing the devices and it was determined that because of the internal circuitry and the fact the team is only discharging the batteries in a controlled manner, that the risk is very minimal for this experiment.

D. Other relevant mechanical information.

NONE

POWER SPECIFICATIONS

A. Measured current draw at 28 VDC

The payload will be using 2 custom data acquisition units that will require the 28 VDC from the HASP vehicle. The power supply of the data acquisition units will have diode protection and a LDO voltage regulator for all of the electronics on the board. Based on the datasheet for the voltage regulator (LM7805), the input voltage rating is 35VDC. Assuming the 28VDC is somewhat regulated, this will provide a stable +5 VDC source needed for the data acquisition system.

The current draw was measured using a LAMBDA 40VDC power supply and a FLUKE 73III multi-meter (in DC, 300mA mode). The measured current for each board (at full draw) is approximately 57.5mA. **Therefore, the two boards included in the payload will draw approximately 115mA at full operation.**

B. If HASP is providing power to your payload, provide a wiring diagram…

A detailed schematic of the entire system is included as Appendix B of this document. The schematic is an exact representation of the system that has been prototyped and is being tested.

C. Other relevant power information

NONE

DOWNLINK TELEMETRY SPECIFICATIONS

The UA-SHAPE experiment uses two types of data loggers. The first is a custom, microcontroller based board that will measure terminal voltages with and without a load. This board uses an SPI EEPROM memory IC to save the data during the flight. The data will be recovered upon completion of the flight using the UA-SHAPE laptop PC. The second data logger is a commercial off the shelf (COTS) unit that will be used to measure the open-terminal voltages of the energy storage devices. It is battery powered and will retain the data in its memory until cleared. Because all data will be stored in the payload **NO DOWNLINK TELEMETRY IS REQURED FOR THIS PAYLOAD**.

UPLINK COMMANDING SPECIFICATIONS

NO SERIAL UPLINK CAPABILITIES ARE REQUIRED FOR THIS PAYLOAD

INTEGRATION AND LOGISTICS

A. Date and time of your arrival for integration

The team will be traveling from Tuscaloosa, Al with an anticipated arrival on July 27th. Therefore, integration can take place on July 28th at 9:00am. This date was chosen because multiple members of the team are working at other locations, and will need a day to travel to meet the team. This can serve as the primary window. The secondary window can be for the team to arrive on Saturday, July 21st and integrate the payload on Sunday, July 22nd. These dates will also ensure that all team members can meet safely and integrate the payload.

B. Approximate amount of time to integrate the payload

The UA-SHAPE payload is very simple and will only require the mounting base to be attached to the main vehicle and functionality testing. Integration and testing should not take longer than 2 hours. The housing, including data logging devices will be integrated during the integration period. Approximately one hour prior to the flight, the payload will need to be accessed to charge the energy storage devices and to start the data logging devices. Approximately one hour prior to the flight, approximately 20 to 30 minutes will be needed to perform these tasks.

C. Name of integration team leader
D. E-mail address of team leader

The UA-SHAPE team leader is Rachael Greene. Her e-mail is Green133@bama.ua.edu.

E. All integration participants with e-mail addresses

Mike Marcel, Ph.D.	mmarcel@ieee.org
John Baker, Ph.D.	John.baker@eng.ua.edu
Rachael Greene	Green133@bama.ua.edu
Taylor Cochran	Cochr011@bama.ua.edu
Shawn Thomas	Thoma236@bama.ua.edu

F. Determine a successful integration of your payload

The payload is very simple; therefore integration should be very easy. Upon completion of integration, the system will use power from the main vehicle to allow the integration team access to start the data acquisition systems quickly, prior to the flight. The payload simply will need to be bolted to the main vehicle using the mounting plate during the integration phase. Upon mounting the team will apply known voltages to the energy storage device terminals and ensure the correct data is being reported through the data link to the UA-SHAPE computer. Upon completion of 10 minutes of data logging, the data will be retrieved using the data link and compared to test voltages to ensure accuracy. Both data logging boards will be tested after being integrated to the payload. Successful integration will yield the correct 10 minutes of data during the testing phase with the payload in place on the main vehicle.

G. List all expected integration steps

1. Connect the mounting plate to the main vehicle.

2. Connect the +28 VDC from the mounting plate to the UA-SHAPE experiment.
3. Connect the RS-232 cable from the UA-SHAPE laptop to the experiment and turn on power.
4. Ensure the system is logging data correctly and at the proper time intervals (using the RS-232 link on the UA-SHAPE experiment).

H. List all checks that will determine a successful integration

1. The UA-SHAPE experiment is powered by the HASP vehicle (GREEN LED)
2. The UA-SHAPE experiment communicates via the RS-232 link to the UA-SHAPE computer.
3. The UA-SHAPE experiment acquires and stores the test voltages applied by the energy storage device terminals.
4. Correct data is successfully recovered.

I. List any additional LSU personnel support needed.

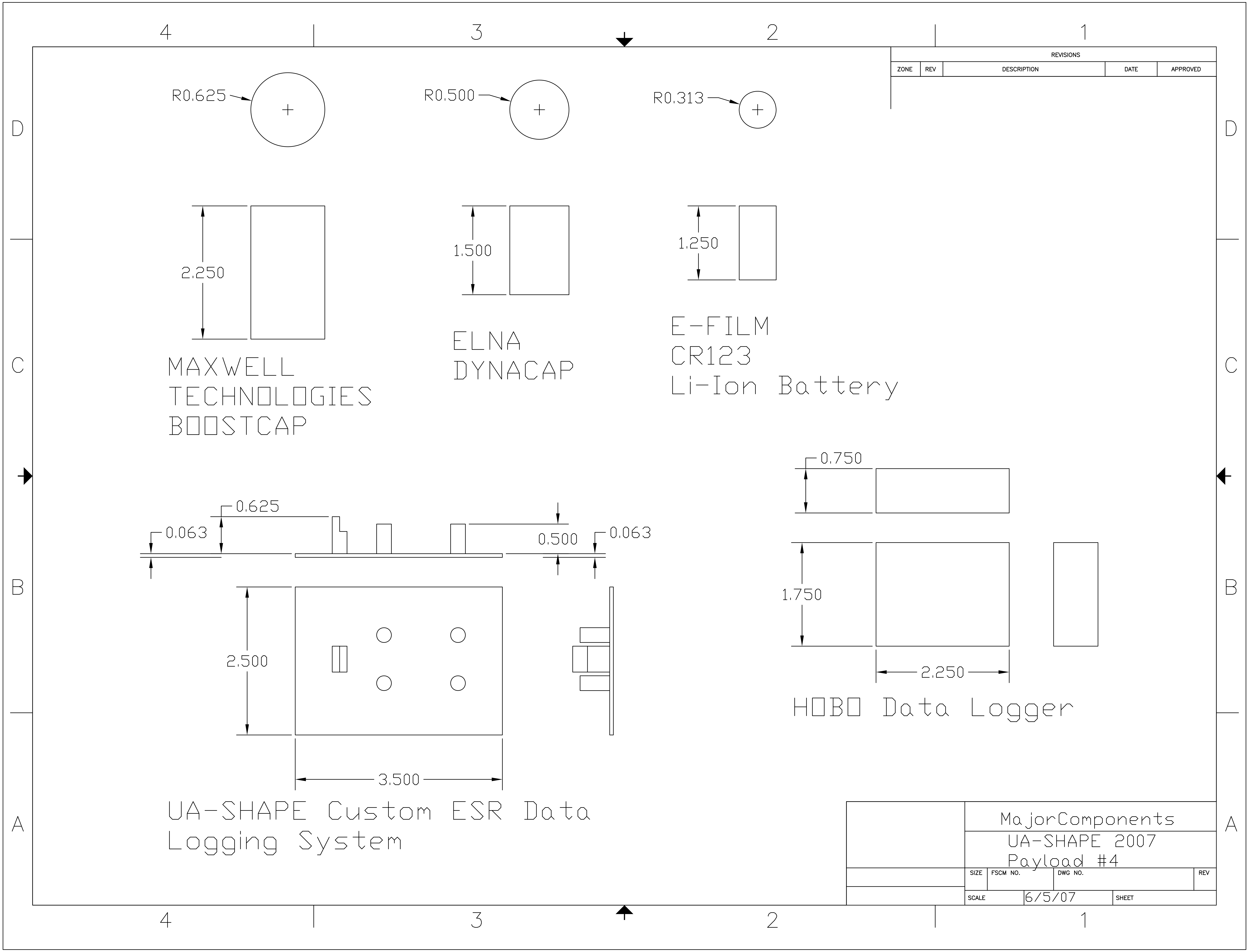
LSU support personnel will be required to help the team mount their payload in the correct position. Also, LSU personnel will be required to provide the 28 VDC needed for testing the integrated payload.

J. List any LSU supplied equipment needed.

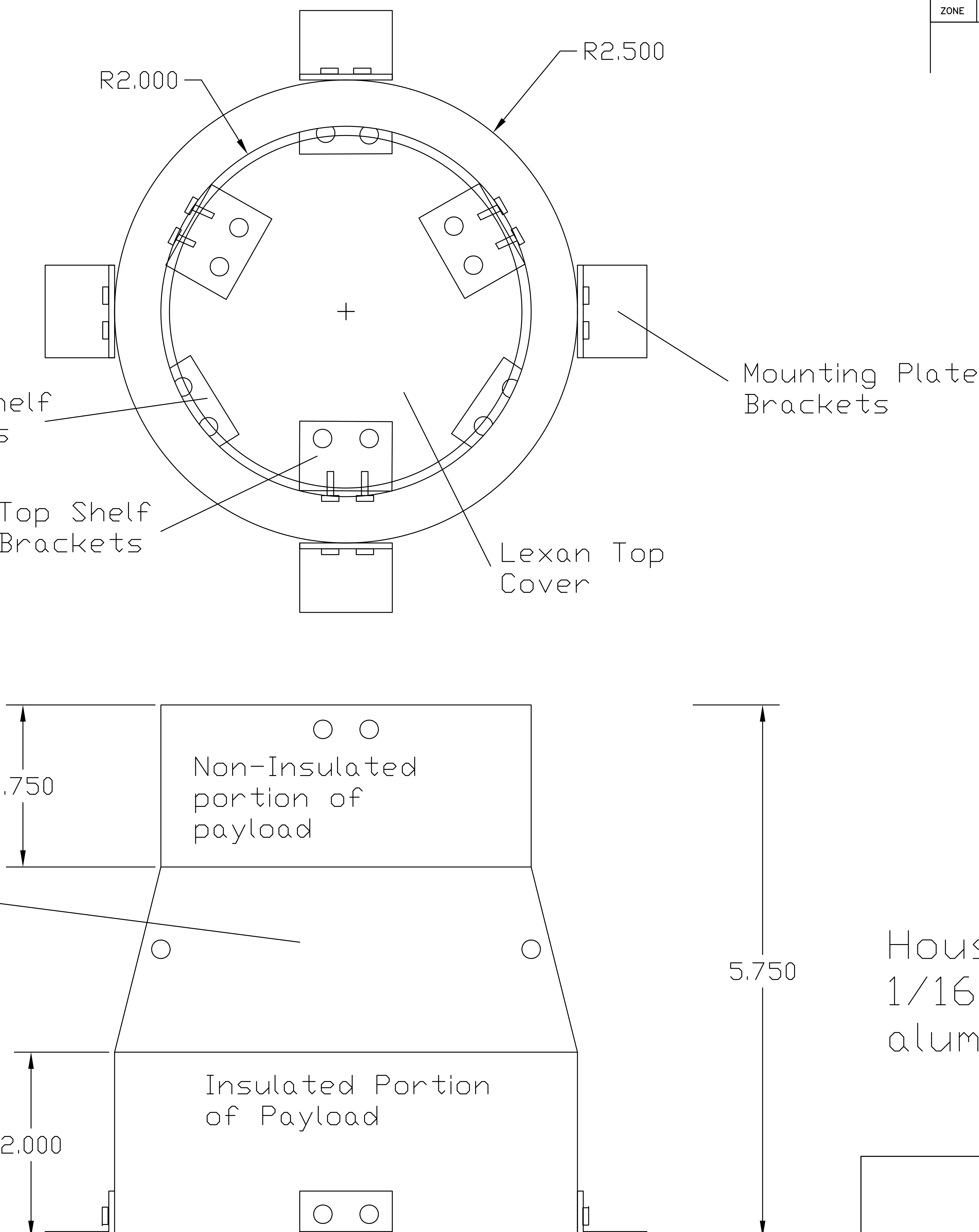
Hand tools that will be used to mount the payload to the HASP vehicle will be required. The team will also bring its own toolbox, multi-meters and oscilloscope for use during testing. 120 VAC wall-power will be needed to power the laptop and oscilloscope (if needed) during the integration phase.

HASP Payload Integration
Appendix A

1. **Diagram of major components of UA-SHAPE payload.**
2. **Diagram of UA-SHAPE housing to be mounted onto mounting plate.**
3. **Diagram of housing and components for UA-SHAPE payload.**



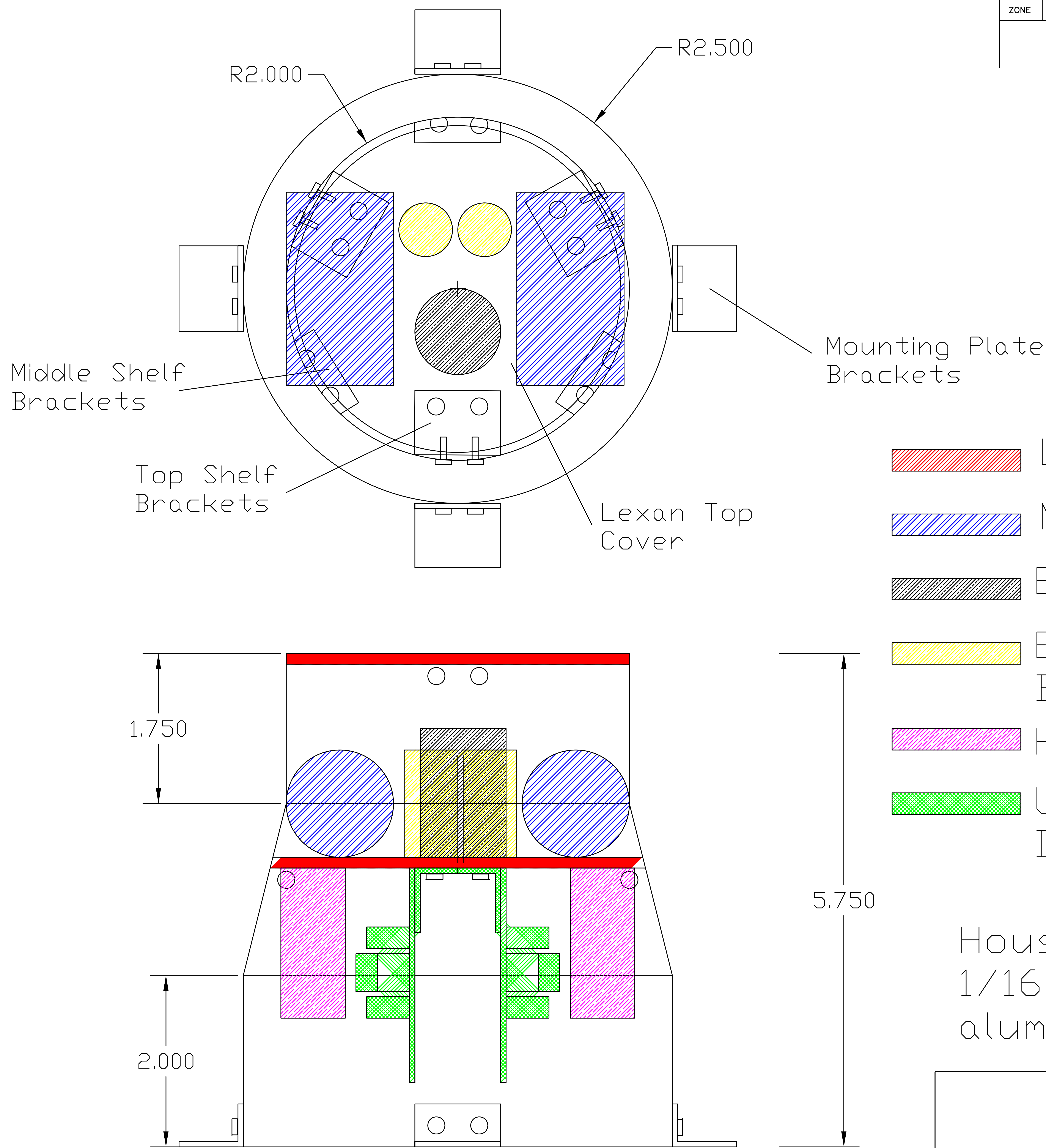
R0.625
R0.500
R0.313
REVISIONS
ZONE
REV
DESCRIPTION
DATE
APPROVED
2.250
1.500
1.250
MAXWELL
TECHNOLOGIES
BOOSTCAP
ELNA
DYNACAP
E-FILM
CR123
Li-Ion Battery
0.625
0.063
0.500
0.063
2.500
3.500
UA-SHAPE Custom ESR Data
Logging System
0.750
1.750
2.250
HOBO Data Logger
MajorComponents
UA-SHAPE 2007
Payload #4
SIZE
FSCM NO.
DWG NO.
REV
SCALE
6/5/07
SHEET



Housing material is 1/16" double-thick aluminum

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED

Housing Diagram	
UA-SHAPE 2007 HASP Payload #4	
SIZE / FSCM NO. / DWG NO.	REV
SCALE 6/5/07	SHEET



- Lexan Shelf
- Maxwell Boostcap
- Elna Dynacap
- E-film Li-ion Battery
- HOBO Datalogger
- UA-SHAPE Custom Data Logger

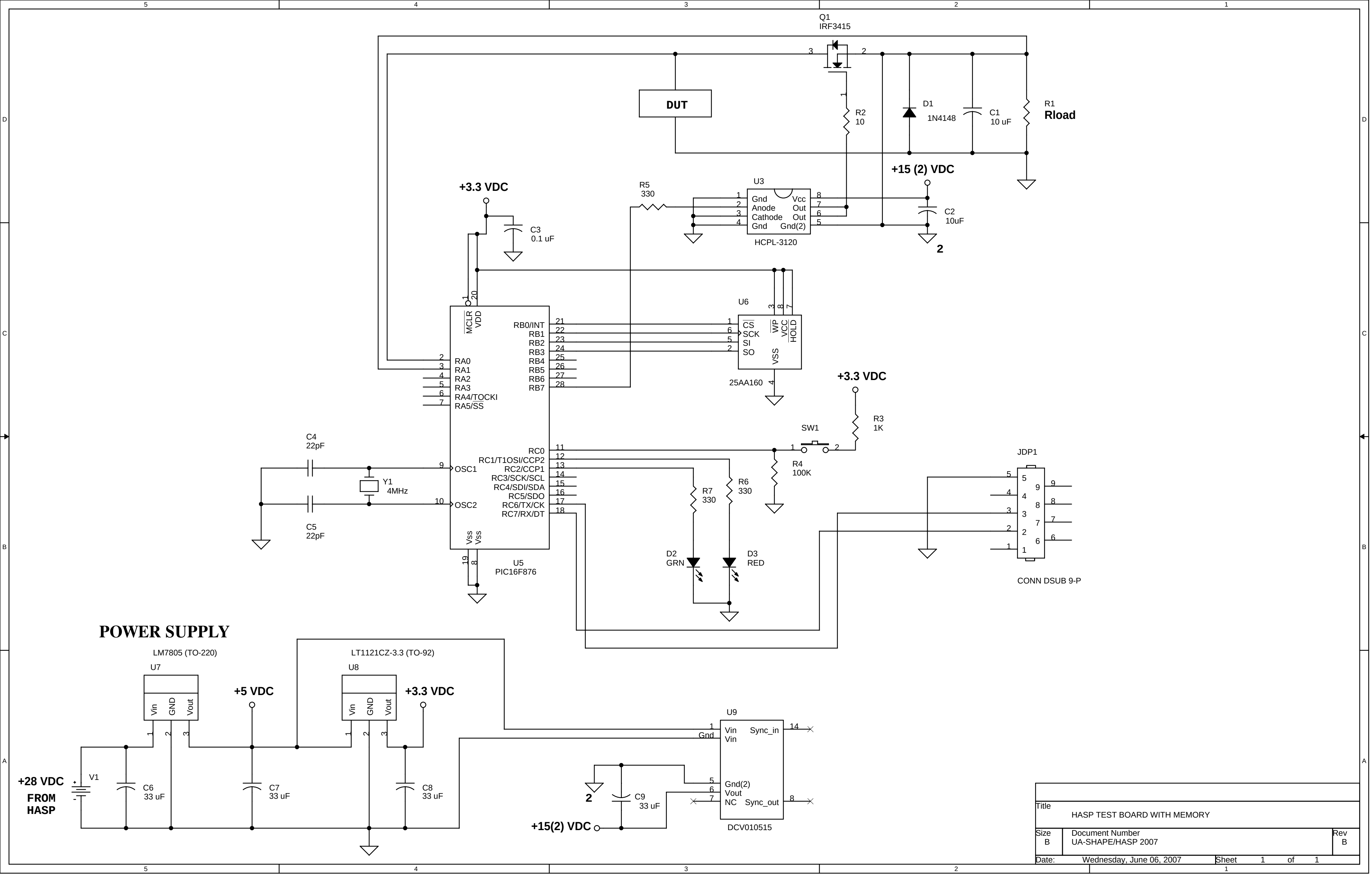
Housing material is 1/16" double-thick aluminum

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED

Housing Diagram with majorcomponents			
UA-SHAPE 2007			
HASP Payload #4			
SIZE	FSCM NO.	DWG NO.	REV
SCALE	6/5/07	SHEET	

HASP Payload Integration
Appendix B

1. Schematic of UA-SHAPE custom data acquisition system powered by HASP +28 VDC source.



Q1
IRF3415
DUT
R1
Rload
R2
10
D1
1N4148
C1
10 uF
+3.3 VDC
C3
0.1 uF
R5
330
U3
Gnd
Anode
Cathode
Gnd
Vcc
Out
Out
Gnd(2)
HCPL-3120
+15 (2) VDC
C2
10uF
2
U6
CS
SCK
SI
SO
WP
VCC
HOLD
VSS
25AA160
MCLR
VDD
RB0/INT
RB1
RB2
RB3
RB4
RB5
RB6
RB7
RA0
RA1
RA2
RA3
RA4/TOCKI
RA5/SS
RC0
RC1/T1OSI/CCP2
RC2/CCP1
RC3/SCK/SCL
RC4/SDI/SDA
RC5/SDO
RC6/TX/CK
RC7/RX/DT
OSC1
OSC2
Vss
Vss
U5
PIC16F876
C4
22pF
C5
22pF
Y1
4MHz
+3.3 VDC
R3
1K
SW1
R4
100K
R7
330
R6
330
D2
GRN
D3
RED
JDP1
CONN DSUB 9-P
POWER SUPPLY
LM7805 (TO-220)
U7
Vin
GND
Vout
+5 VDC
LT1121CZ-3.3 (TO-92)
U8
Vin
GND
Vout
+3.3 VDC
+28 VDC
FROM
HASP
V1
C6
33 uF
C7
33 uF
C8
33 uF
U9
Vin
Vin
Gnd
Sync_in
Gnd(2)
Vout
NC
Sync_out
DCV010515
C9
33 uF
2
+15(2) VDC
Title
HASP TEST BOARD WITH MEMORY
Size
B
Document Number
UA-SHAPE/HASP 2007
Rev
B
Date: Wednesday, June 06, 2007
Sheet 1 of 1