To: Dr. Gregory Guzik
From: Jayson Nissen
Attn: Specification and Integration Plan for MSU's Experiment
Date: May 29, 2009

Dr. Guzik,

Attached are our integration plan as well as electronic and mechanical schematics and drawings for our project. In this letter I will cover in greater detail our laser particle detector, changes to this year's experiment and your comments from January 6, 2009.

Changes:

This year a latching mechanism has been incorporated to ensure the box stays closed in the event of a less than optimal landing. A laser particle detector (LPD) has been incorporated into the design to actively measure particle flux and size throughout the flight. Flight electronics have been changed to account for these two additions. Two microprocessors will be flown to allow for greater data collection and control abilities. This year, the discrete commands will be handled by a separate control system. This system is completely independent of all other electronics and can open or close the box.

Laser Particle Detector (LPD):

The LPD uses a 640 nm red diode laser with an operating current of 35 mA to measure particles in the 2-100 micrometer range. The particles refract some of the laser light when they pass through the beam; the refracted light is collected by a mirror and focused onto a photo-diode, generating a voltage output. The voltage output data is stored on board the experiment on a USB drive. The particles are transported using two positive displacement pumps. Each pump's operating current is 50-900mA depending on environmental conditions. We expect that they will operate on the low end of the current spectrum due to the low pressure at altitude, and will verify this in the upcoming weeks.

Comments:

The LPD will be mounted to an optics plate inside the electronics box. The plate will be made of aluminum due to its low cost and relatively low thermal expansion. Much like the PCBs, the plate will be attached to the electronics box using threaded rods.

To prevent the o-ring from pulling out of the groove and preventing closure of the box, a new type of o-ring will be used. Testing will be conducted to verify that this o-ring will remain in the groove. If the new o-ring type does not solve the problem, an adhesive for o-rings is available through McMaster Carr.

The MSU experiment is currently under construction and we expect minor changes. The design of the LPD has not been finalized and is still undergoing testing. We will notify you of any dramatic changes and of the known current draw and weight when available.

Sincerely,

Jayson Nissen

HASP Payload Specification and Integration Plan

Payload Title: Passive High Altitude Capture Experiment

Payload Class: Small [Large] (circle one)

Payload ID: 10

Institution: **Montana State University, Bozeman**

Contact Name: Jayson Nissen

Contact Phone: 406-581-1982

Contact E-mail: Jayson_Nissen@yahoo.com

Submit Date: June 1, 2009

I. Mechanical Specifications:

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

Last year's payload weight was 9.2 kg. The addition of the latch mechanism and laser particle detector (LPD) should add about 2 kg making the max weight 11.5 kg.

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

A mechanical drawing of our experiment is attached. We intend to drill through the mounting plate, much as we did for our previous flight, so that we can bolt the mounting brackets to the HASP mounting plate. Only the bolt heads will extend beyond the base of the HASP mounting plate.

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.

D. Other relevant mechanical information

The containment box will be removed after integration to allow clean room preparation of the collection plates. This is the same process that was used last year.

II. Power Specifications:

A. Measured current draw at 28 VDC

Peak current draw is 900 mA for operating the heaters or the servos. Current draw of the basic electronics package is 40mA. Current draw of the LPD is estimated at 1 A. This estimate is highly variable and depends on the pump configuration which has not been finalized.

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.

See the attached drawing. Our system connects to the HASP EDAC via a DB9 Connector soldered to our control board. For our control circuitry we regulate the voltage to 5V using a DC/DC converter. We intend to deploy the same DC/DC converter unit that was flown last year.

Other relevant power information:

The LPD is still in design. Electrical layouts will be provided when a design has been finalized.

III. Downlink Telemetry Specifications:

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

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

4800 baud

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

Record Length: 10 bytes

Byte 1: Box lid status sensor data

Byte 2: Port servo temperature

Byte 3: Starboard servo temperature

Byte 4: DC-DC converter temperature

Byte 5: Servo current

Byte 6: Latch Servo 1 temperature

Byte 7: Latch Servo 2 temperature

Byte 8: LPD Pump temperature

Byte 9: LPD Pump current

Byte 10: LPD pulse height counts

D. Number of analog channels being used:

Two

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

LPD laser sensor and LPD temperature

F. Number of discrete lines being used:

Two

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

We plan to use the following two command pairs:

"OPEN/NOACTION"

"CLOSED/NOACTION"

These commands will be used to initiate lid opening/closing operations if the serial commands fail to do so.

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

No

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*)

We will use less than ten commands and at least two (one for opening the capture box and one for closing the capture box).

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

HEX Code	***Purpose of Command***
B008	*Opens the box*
B0C1	*Closes the box*
B04B	*Initiates a heat cycle for both servos*
B03F	*Stops the servo operation*
B0G9	*Turns on the LPD*
B01S	*Turns off the LPD*
B0W3	*Initiates a heat cycle for latch servos*
B0L4	*Latches box*
B0D7	*Unlatches box*
B022	*Stops heater cycle*

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

No

F. Other relevant uplink commanding information:

None

V. Integration and Logistics

A. Date and Time of your arrival for integration:

TBD

B. Approximate amount of time required for integration:

6 hours

C. Name of the integration team leader:

Jayson Nissen

D. Email address of the integration team leader:

jayson_nissen@yahoo.com

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

Tentative list:

Jayson Nissen *jayson_nissen@yahoo.com*

Jennifer Susan Hane *jennifer.hane@myportal.montana.edu*

F. Define a successful integration of your payload:

Box opens via discrete command

Box closes via discrete command

Box latches and unlatches via serial command

Box opens via serial command

Box closes via serial command

Both heater cycles are initiated via serial command

LPD turns on and off via serial command

Proper serial downlink of data from sensors

G. List all expected integration steps:

1) *Connect to HASP platform*
2) *Use discrete uplink to open and close the box*
3) *Use serial uplink to latch and unlatch the box*

4) *Use serial uplink to open and close the box*

5) *Use serial uplink to perform heater cycles on all servos*

6) *Use serial uplink to turn LPD on and off*

7) *Verify download of onboard sensor package*

8) *Verify performance under simulated flight conditions using the BEMCO environmental chamber.*

9) *Remove the capture box for transport to clean room for capture plate integration*

10) *Verify that the remainder of the experiment is in a shippable state*

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

1) *Completion of all steps in part F successfully*

2) *Successful system operation in the BEMCO environmental chamber*

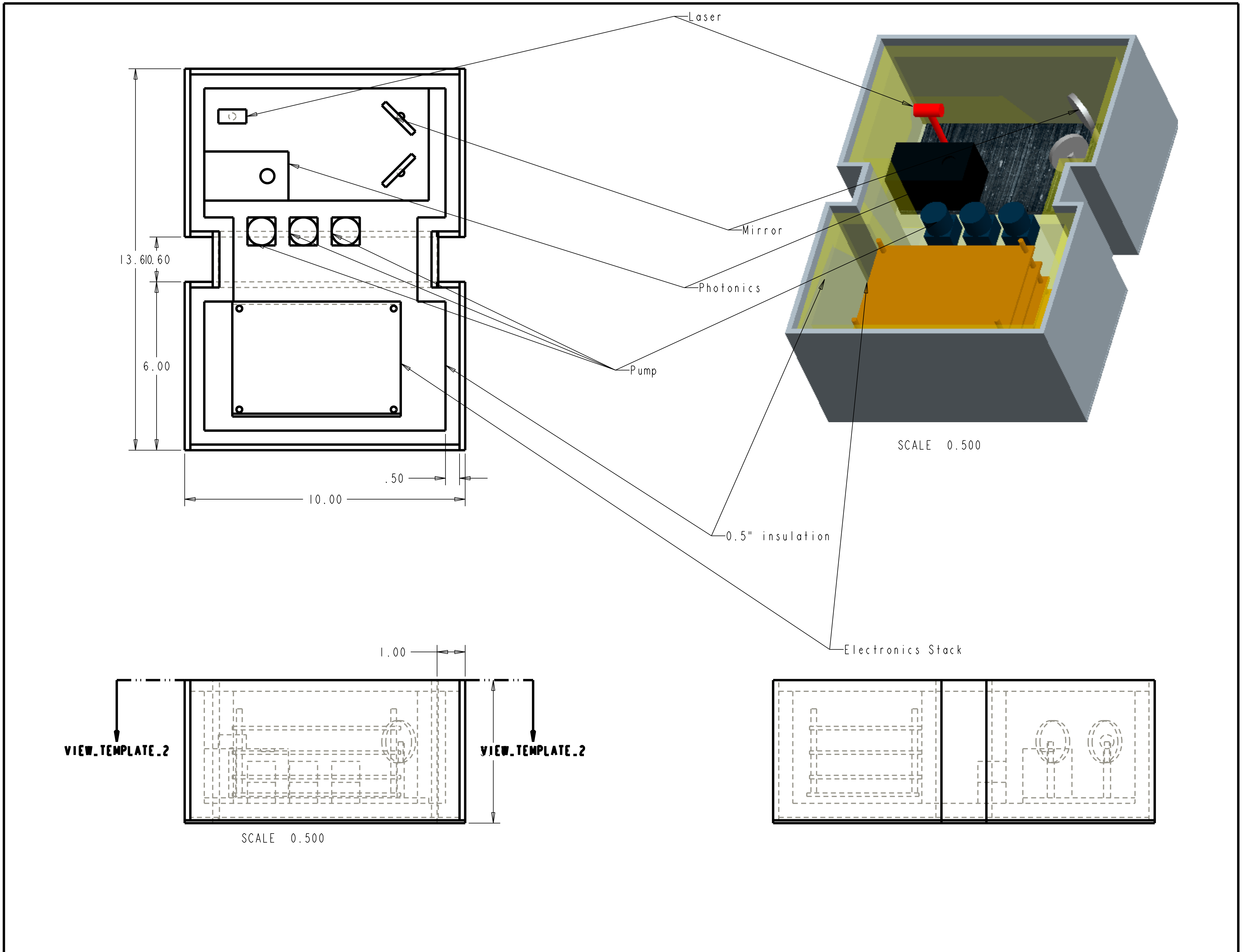
3) *Removal of the capture box for transportation to a clean room facility*

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…):

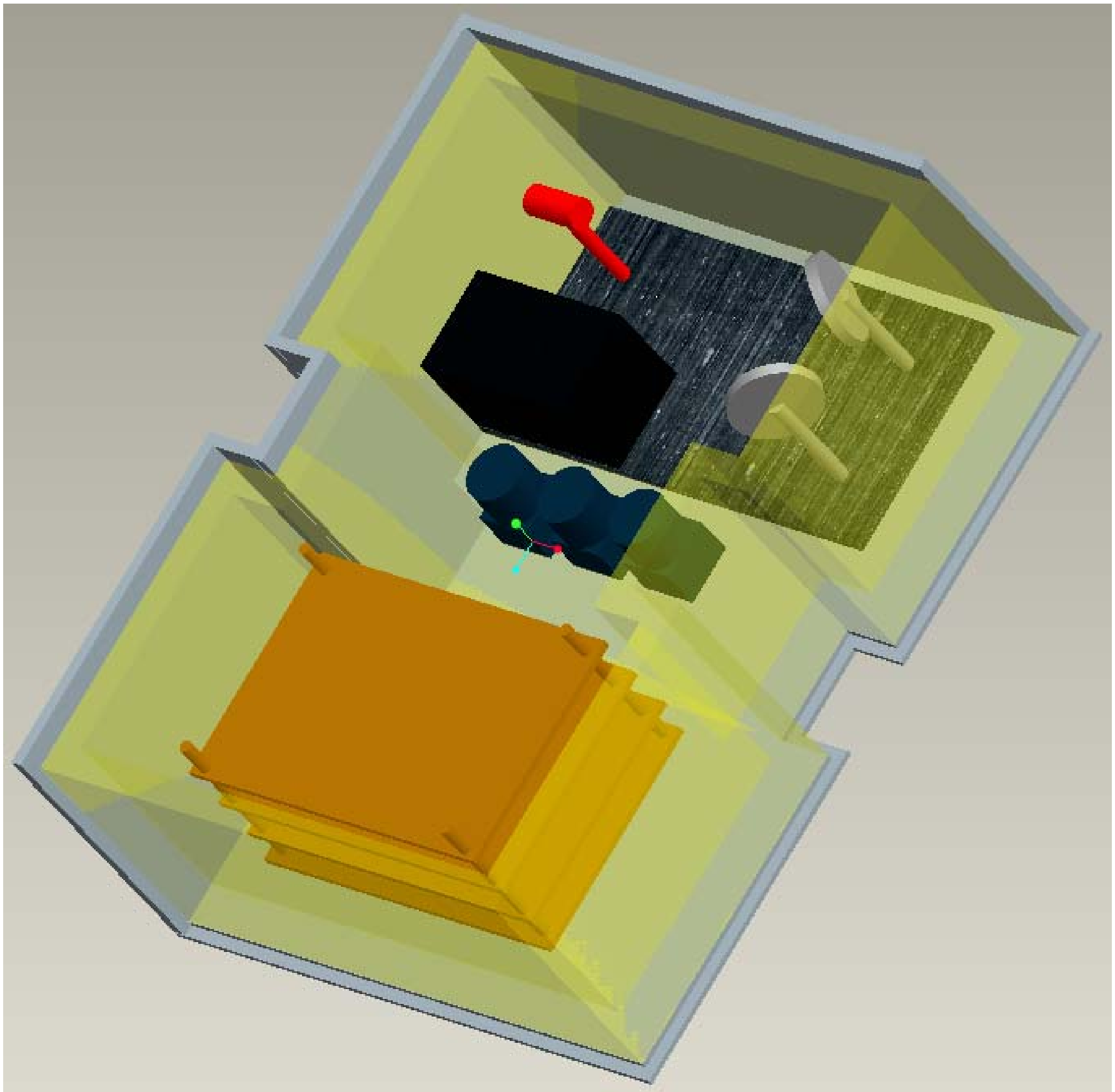
None

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

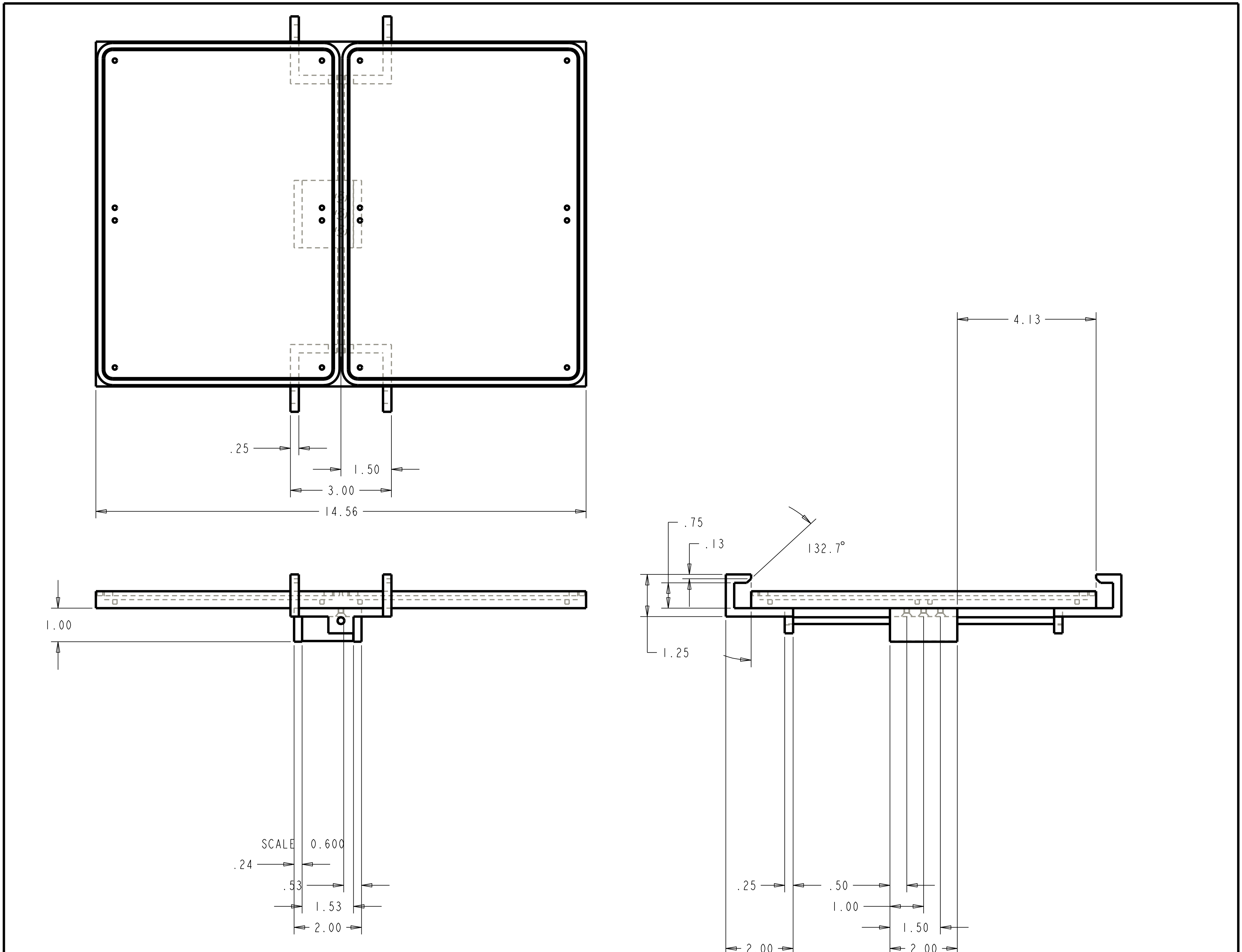
DC Power Supply



Laser
Mirror
Photonics
Pump
0.5" insulation
Electronics Stack
13.61
0.60
6.00
.50
10.00
SCALE 0.500
1.00
VIEW_TEMPLATE_2
VIEW_TEMPLATE_2
SCALE 0.500



Electronics box assembly: PCB stack (copper), pumps (blue), focusing mirrors (silver), laser (red), photonics (black), insulation (translucent yellow).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1.50
3.00
14.56
1.00
SCALE 0.600
.24
.53
1.53
2.00
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.75
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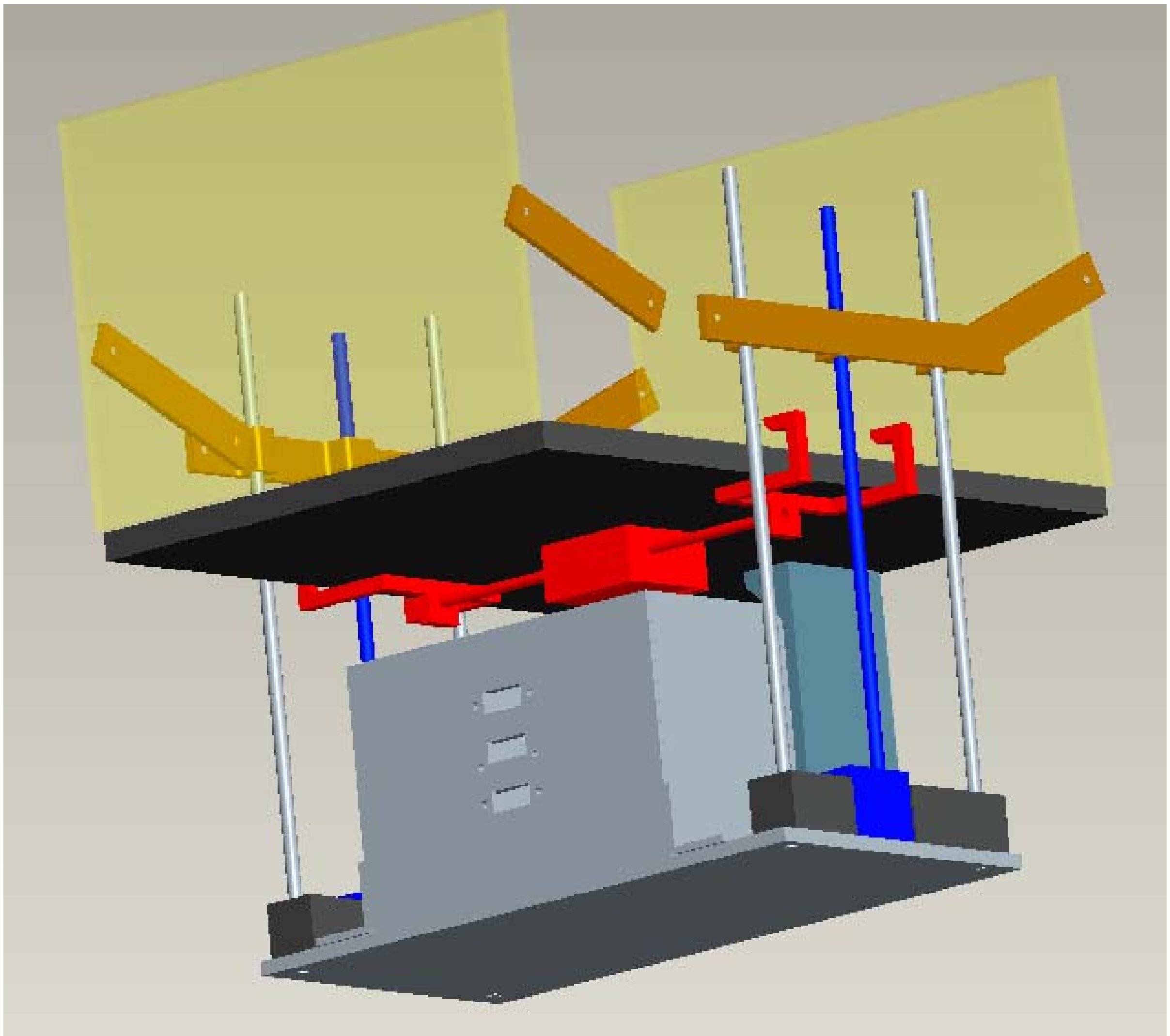
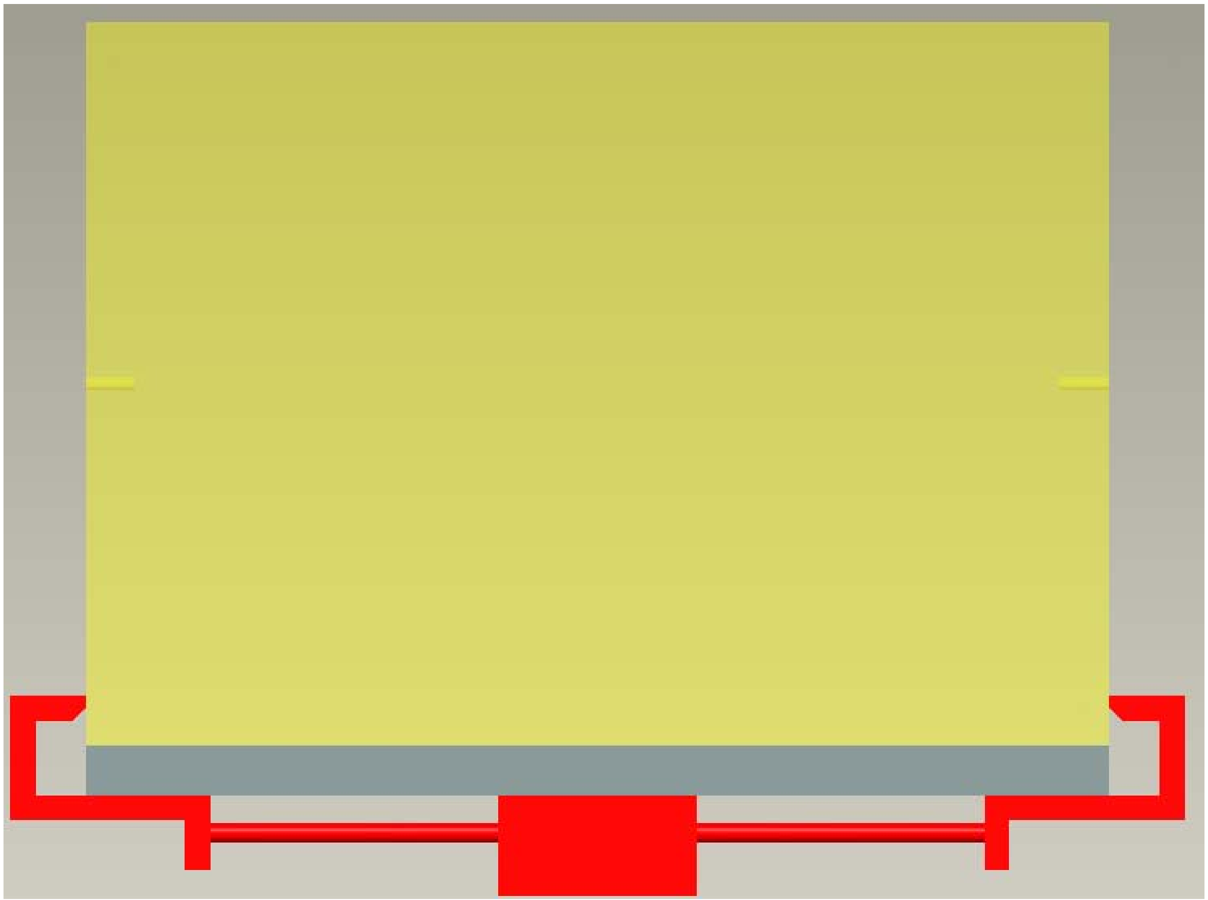
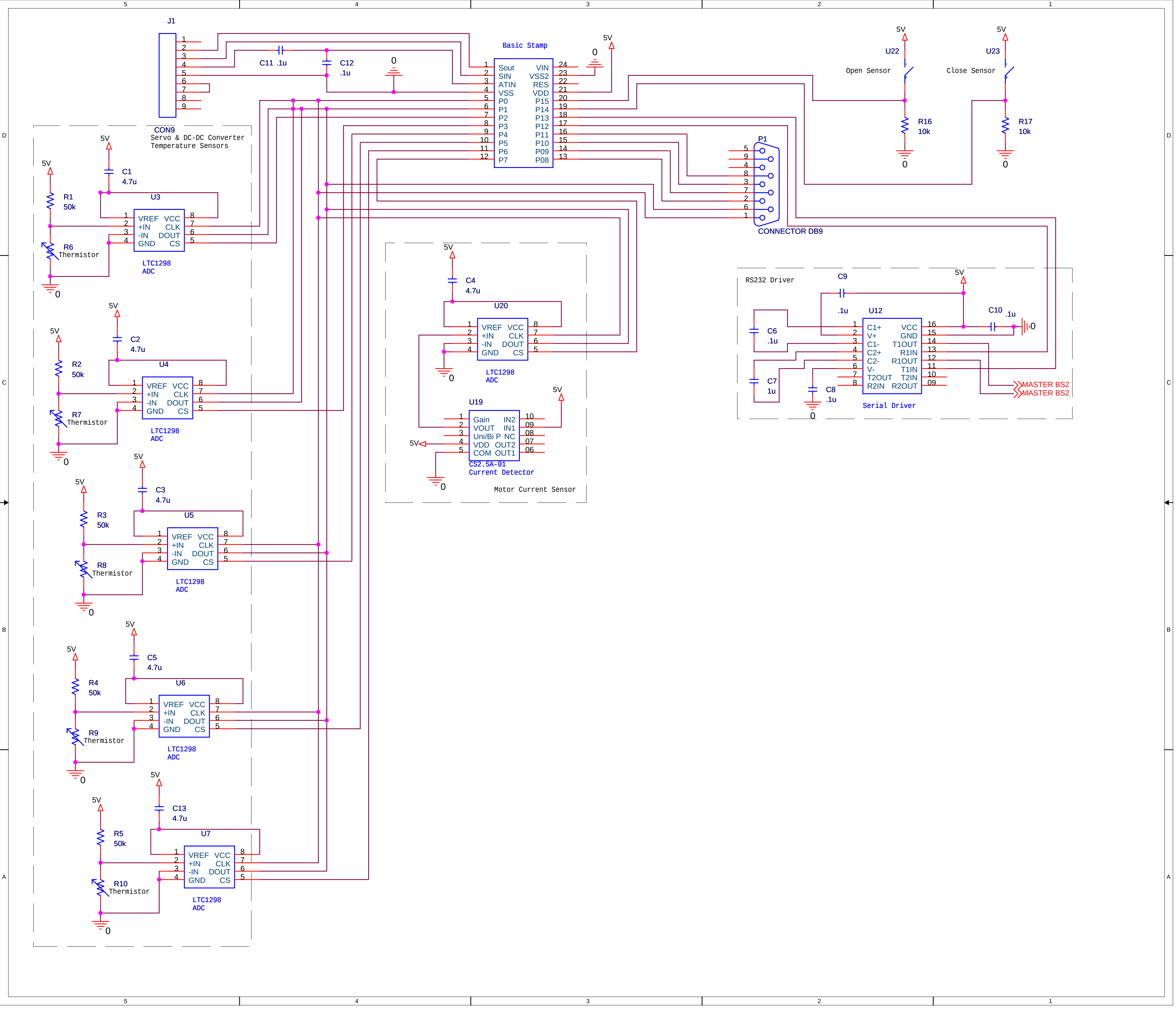
1.50
2.00
2.00



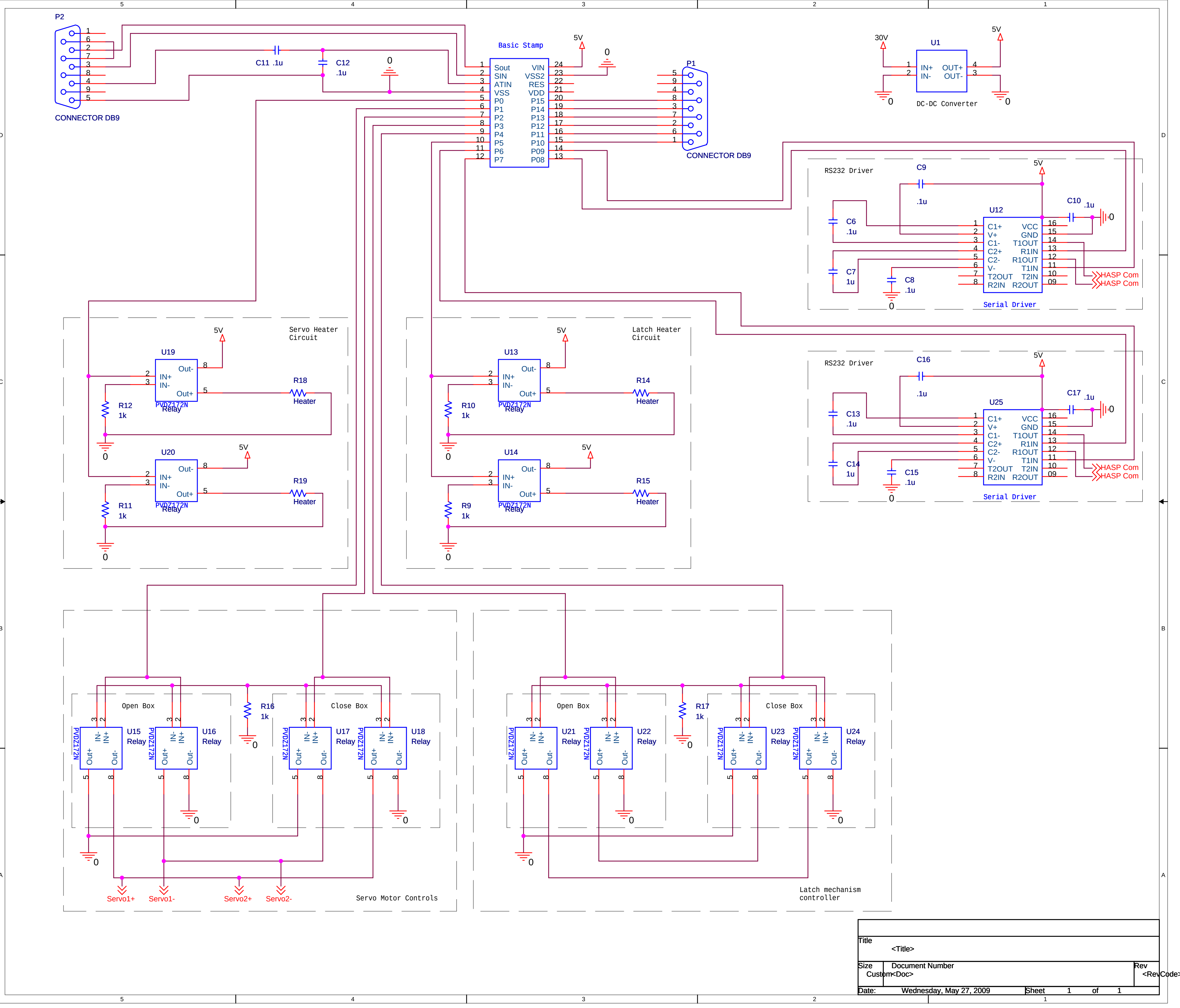
Latching mechanism (red) attached to the complete HASP assembly.



Side view of the latching mechanism (red) under the containment box in the open position.



J1
CON9
Servo & DC-DC Converter
Temperature Sensors
C11 .1u
C12 .1u
Basic Stamp
Sout SIN ATIN VSS P0 P1 P2 P3 P4 P5 P6 P7
VIN VSS2 RES VDD P15 P14 P13 P12 P11 P10 P09 P08
5V
0
U22
Open Sensor
U23
Close Sensor
R16 10k
R17 10k
P1
CONNECTOR DB9
U3
C1 4.7u
R1 50k
R6 Thermistor
VREF VCC +IN CLK -IN DOUT GND CS
LTC1298
ADC
U4
C2 4.7u
R2 50k
R7 Thermistor
U5
C3 4.7u
R3 50k
R8 Thermistor
U6
C5 4.7u
R4 50k
R9 Thermistor
U7
C13 4.7u
R5 50k
R10 Thermistor
U20
C4 4.7u
U19
Gain VOUT Uni/Bi P VDD COM IN2 IN1 NC OUT2 OUT1
CS2.5A-01
Current Detector
Motor Current Sensor
RS232 Driver
C9 .1u
U12
C10 .1u
C6 .1u
C7 1u
C8 .1u
C1+ V+ C1- C2+ C2- V- T2OUT R2IN VCC GND T1OUT R1IN R1OUT T1IN T2IN R2OUT
Serial Driver
MASTER BS2
MASTER BS2



P2
CONNECTOR DB9
C11 .1u
C12
.1u
Basic Stamp
Sout
SIN
ATIN
VSS
P0
P1
P2
P3
P4
P5
P6
P7
VIN
VSS2
RES
VDD
P15
P14
P13
P12
P11
P10
P09
P08
5V
0
P1
CONNECTOR DB9
30V
U1
IN+
IN-
OUT+
OUT-
DC-DC Converter
RS232 Driver
C9
.1u
C10
U12
C6
C7
1u
C8
C1+
V+
C1-
C2+
C2-
V-
T2OUT
R2IN
VCC
GND
T1OUT
R1IN
R1OUT
T1IN
T2IN
R2OUT
HASP Com
HASP Com
Serial Driver
C16
C17
U25
C13
C14
C15
Servo Heater
Circuit
U19
Out-
IN+
IN-
Out+
PVDZ172N
Relay
R18
Heater
R12
1k
U20
R19
R11
Latch Heater
Circuit
U13
R14
R10
U14
R15
R9
Open Box
Close Box
U15
U16
U17
U18
R16
U21
U22
U23
U24
R17
Servo1+
Servo1-
Servo2+
Servo2-
Servo Motor Controls
Latch mechanism
controller
Title
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Size
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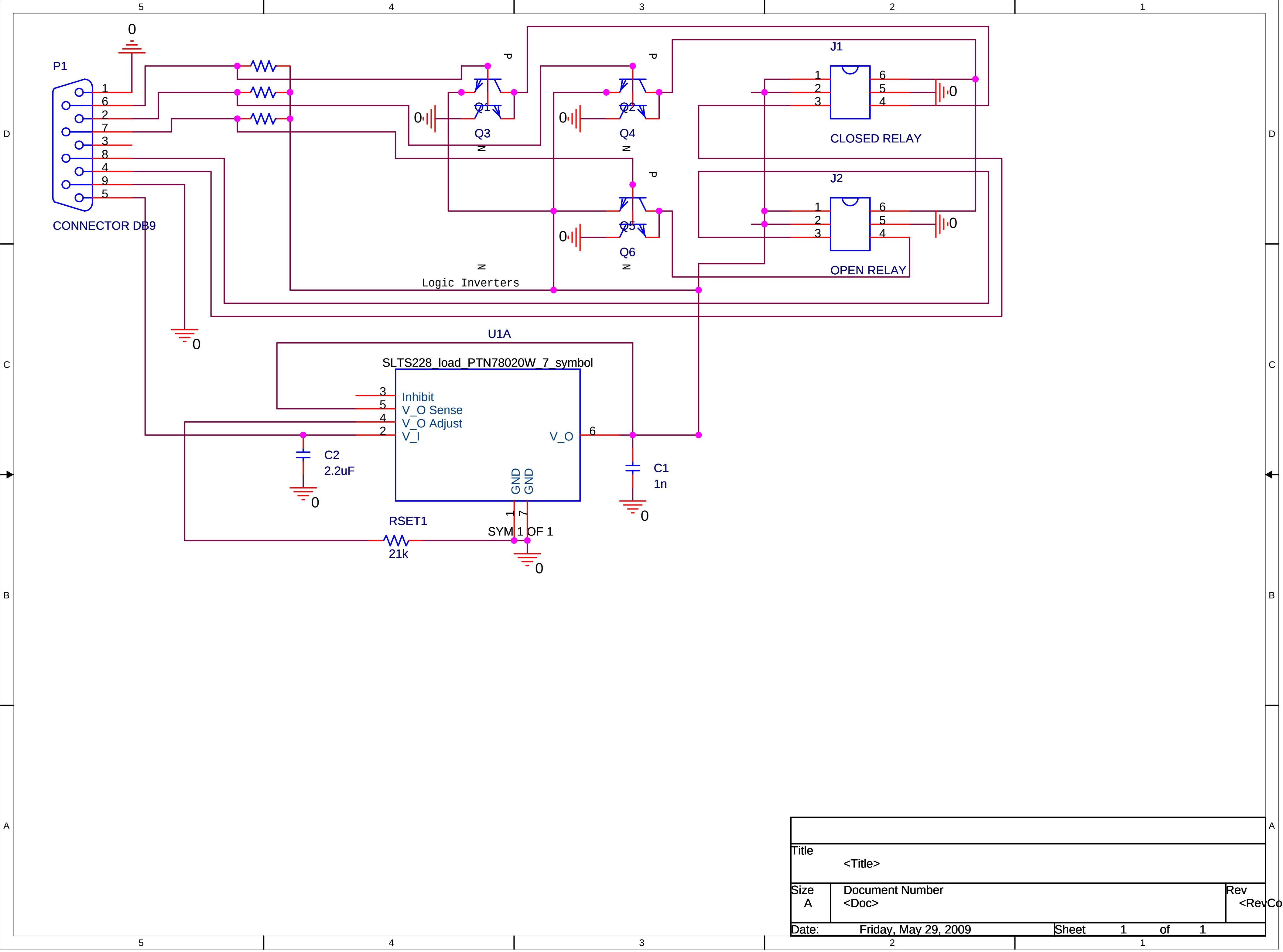
Document Number
<Doc>
Rev
<RevCode>
Date: Wednesday, May 27, 2009
Sheet 1 of 1



P1
CONNECTOR DB9
1
6
2
7
3
8
4
9
5
0
Q1
Q2
Q3
Q4
Q5
Q6
P
N
J1
CLOSED RELAY
J2
OPEN RELAY
Logic Inverters
U1A
SLTS228_load_PTN78020W_7_symbol
Inhibit
V_O Sense
V_O Adjust
V_I
V_O
GND
GND
C2
2.2uF
C1
1n
RSET1
21k
SYM 1 OF 1
Title
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Size
A
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Rev
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Date:
Friday, May 29, 2009
Sheet
1
of
1