MiniSShot

Vehicle Mass Statement

Iteration #1A

Rev.2007/06/30

General information

This document outlines the mass estimates of the MiniSShot rocket vehicle and its individual components.

This revision represents iteration #1 and is intended to be used as a preliminary basis for design, trajectory simulations, vehicle geometric configuration and stability analysis.

All dimensions are estimates typically based on scaling down eXSShot* to 1/3, with the exception of the motor, for which masses and dimensions are based on the ProtoSShot-M Mark I

Revision 1A of this document includes the results of centre of gravity analysis for the vehicle.

*configuration dph49 http://sugarshot.org/downloads/config_dph49.gif

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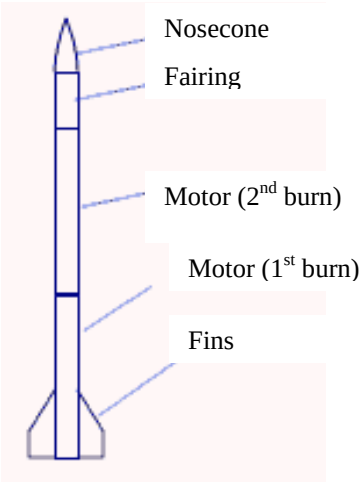
Component Definitions



Complete vehicle

Item	Launch mass		Post 1st burn mass		Post 2nd burn (=dry mass)	
	kg	lbs	kg	lbs	kg	lbs
Motor	15.74	34.71	10.39	22.91	4.74	10.46
Fairing	0.242	0.53	0.242	0.534	0.242	0.534
Noscone	0.246	0.54	0.246	0.542	0.246	0.542
Fins	0.220	0.49	0.220	0.486	0.220	0.486
Recovery system	1.5	3.31	1.500	3.307	1.500	3.307
Payload (avionics)	1.5	3.31	1.500	3.307	1.500	3.307
Miscellaneous	0	0.00	0.000	0.000	0.000	0.000
Total =>	**19.45**	**42.89**	**14.10**	**31.09**	**8.45**	**18.64**

Mass fraction *	**0.548**

** Ratio of propellant mass to vehicle launch mass*
Required mass ratio for eXSShot is 0.80

The preliminary target mass fraction for MiniSShot is 0.60

For DoubleSShot, the target mass fraction is expected to be 0.70

Motor	Unit mass	units	Quantity	Mass	
Component	value			kg	lb
propellant first burn	5.332	kg		5.332	11.755
propellant second burn	5.332	kg		5.332	11.755
casings	1.077	kg/m	1.756	1.891	4.168
nozzle ring	365	g		0.365	0.806
nozzle shell	420	g		0.420	0.926
insert	60	g		0.060	0.132
Ring thermal insulation	30	g	2	0.060	0.132
nozzle screws	1.17	g/screw	30	0.035	0.077
nozzle o-rings	3.5	g	2	0.007	0.015
nozzle misc	50	g	1	0.050	0.110
casting/inhibitor tubes	0.243	kg/m	1.62	0.394	0.868
casing thermal insulation, 1st chamber	0.0865	g/cm^2	4292	0.371	0.819
casing thermal insulation, 2nd chamber	0.0250	g/cm^2	2146	0.054	0.118
casing thermal barrier, 1st chamber	0.0406	g/cm^2	2146	0.087	0.192
casing thermal barrier, 2nd chamber	0.0406	g/cm^2	2146	0.087	0.192
pyrogen charge	20	g	1	0.020	0.044
midbulkhead shell	516	g		0.516	1.138
midbulkhead thermal liner	70	g	1	0.070	0.154
midbulkhead misc	0	g	1	0.000	0.000
midbulkhead screws	1.17	g/screw	48	0.056	0.124
midbulkhead o-rings	3.5	g	4	0.014	0.031
RNX delay charge	150	g	1	0.150	0.331
burst diaphragms	3	g	2	0.006	0.013
forward bulkhead	200	g		0.200	0.441
forward bulkhead screws	1.17	g/screw	24	0.028	0.062
forward bulkhead o-rings	3.5	g	2	0.007	0.015
pyrogen canister	40	g	1	0.040	0.088
pyrogen charge	20	g	1	0.020	0.044
pressure sensors	50	g	1	0.050	0.110
2nd burn igniter + wiring	10	g	1	0.010	0.022
motor assembly misc				0.000	0.000

post 2nd burn	4.863	kg	10.7	lb
post 1st burn	10.381	kg	22.9	lb
at launch	15.733	kg	34.7	lb

Motor mass ratio = **0.677**

Fins

A =	7.792in
B =	3.896in
C =	3.896in
N =	4
Area =	22.76944in2

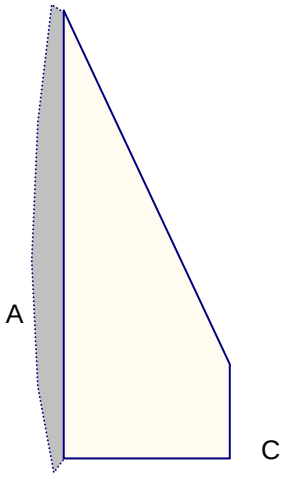
Monolithic

t =	0.1in
density =	0.100lb/in3
est. fin mass =	0.228lb each
est. fins mass =	**0.91lb total**

Composite(2 skins with core)

skin density =	0.068lb/in3
core density =	0.001lb/in3
skin t =	0.030in (avg.)
core t =	0.188in (avg.)
core mass =	0.0043lb
skin mass (ea.) =	0.0464lb
est. fin mass =	0.0972lb each
est. fairing mass =	0.0243lb each

est. fins mass =	**0.486lb total**	composite
	0.220kg total	



grey portion is fin/fuse fairing

Fairing Fuselage
(houses recovery system)

1) Assume made of same material as motor casing (glass/epoxy laminate)

Unit mass value	units	Quantity	Mass	
1.077	kg/m	0.56	**0.602**	**kg**
	inches	22.00	**1.326**	**lb**

Di =	**3.32**	**in.**	**Internal diameter**
Vi =	**190.5**	**cu.in.**	**Internal volume**

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2) Assume made of composite sandwich (glass/epoxy/nomex honeycomb)

SANDWICH MATERIAL

height =	22.00	in
Outer diameter =	3.50	in
Outer skin thickness =	0.020	in
Inner skin thickness =	0.010	in
core thickness =	0.250	in
skin material density =	0.055	lb/in3
core material density =	0.00231	lb/in3
est. mass =	**0.534**	**lbs.**
	0.242	**kg.**

Di =	**2.94**	**in.**	**Internal diameter**
Vi =	**149.4**	**cu.in.**	**Internal volume**

Recovery System (complete)

1.5	kg
3.307	lb

Avionics (including support structure)

1.5	**kg**
3.307	**lb**

Nosecone

Surface area of a right circular cone

SOLID (HOMOGENOUS) MATERIAL		
height =	19.25	in
base radius =	3.5	in
surface area =	215	in2
wall thickness =	0.040	in

SANDWICH MATERIAL		
height =	19.25	in
base radius =	3.5	in
surface area =	215	in2
Outer skin thickness =	0.030	in
Inner skin thickness =	0.020	in
core thickness =	0.250	in

Estimated mass of conical nosecone

density =	0.060	lb/in3
est. mass =	**0.52lbs.**	
	0.234kg.	
Volume =	61.7in^3	

Estimated mass of conical sandwich nosecone

skin material density =	0.06	lb/in3
core material density =	0.002315	lb/in3
est. mass =	**0.77lbs.**	
	0.349kg.	

Adjustment factor for actual nosecone profile if not right circular:

factor =	1.05	
est. mass =	**0.54lbs.**	
	0.246kg.	

Fins (4 fins)	**mass =**	**0.486**	**lb.**	**0.220**	**kg.**
	zbar =	**108.1**	**in.**	**2746**	**mm**
	mass * zbar =	**52.526**	**lb-in**	**605.2**	**kg-mm**
Nosecone	**mass =**	**0.542**	**lb.**	**0.246**	**kg.**
	zbar =	**12.83**	**in.**	**326**	**mm**
	mass * zbar =	**6.957**		**80.2**	**kg-mm**
Fairing	**mass =**	**0.510**	**lb.**	**0.231**	**kg.**
	zbar =	**29.25**	**in.**	**743**	**mm**
	mass * zbar =	**15.858**		**171.8**	**kg-mm**
Recovery System (cg assumed same as fairing)	**mass =**	**3.307**	**lb.**	**1.500**	**kg.**
	zbar =	**29.25**	**in.**	**743**	**mm**
	mass * zbar =	**96.726**		**1114.4**	**kg-mm**
Avionic System (cg assumed same as nosecone)	**mass =**	**3.307**	**lb.**	**1.500**	**kg.**
	zbar =	**12.83**	**in.**	**326**	**mm**
	mass * zbar =	**42.438**		**489.0**	**kg-mm**
Motor System					
Forward bulkhead	**mass =**	**0.783**	**lb.**	**0.355**	**kg.**
	zbar =	**41.81**	**in.**	**1062**	**mm**
	mass * zbar =	**32.729**	**lb-in**	**377**	**kg-mm**
Mid bulkhead	**mass =**	**1.790**	**lb.**	**0.812**	**kg.**
	zbar =	**77.53**	**in.**	**1969**	**mm**
	mass * zbar =	**138.816**	**lb-in**	**1599**	**kg-mm**
Nozzle	**mass =**	**2.184**	**lb.**	**0.990**	**kg.**
	zbar =	**113.97**	**in.**	**2895**	**mm**
	mass * zbar =	**248.860**	**lb-in**	**2867**	**kg-mm**
Casing, 1st burn	**mass =**	**3.532**	**lb.**	**1.602**	**kg.**
	zbar =	**96.04**	**in.**	**2439**	**mm**
	mass * zbar =	**339.242**	**lb-in**	**3909**	**kg-mm**
Casing, 2nd burn	**mass =**	**2.830**	**lb.**	**1.284**	**kg.**
	zbar =	**58.39**	**in.**	**1483**	**mm**
	mass * zbar =	**165.222**	**lb-in**	**1904**	**kg-mm**
Propellant, 1st burn	**mass =**	**11.755**	**lb.**	**5.332**	**kg.**
	zbar =	**95.94**	**in.**	**2437**	**mm**
	mass * zbar =	**1127.760**	**lb-in**	**12993**	**kg-mm**
Propellant, 2nd burn	**mass =**	**11.755**	**lb.**	**5.332**	**kg.**
	zbar =	**58.71**	**in.**	**1491**	**mm**
	mass * zbar =	**690.127**	**lb-in**	**7951**	**kg-mm**
Vehicle					
Launch	**sum mass =**	**42.780**	**lb.**	**19.405**	**kg.**
	sum mass * zbar =	**2957.261**	**lb-in**	**34067.6**	**kg-mm**
	zbar =	**69.13**	**in.**	**1755.6**	**mm**

CG Summary

Vehicle					
Launch	**sum mass =**	**42.780**	**lb.**	**19.405**	**kg.**
	sum mass * zbar =	**2957.261**	**lb-in**	**34067.6**	**kg-mm**
	zbar =	**69.13**	**in.**	**1755.6**	**mm**
Post-1st burn	**sum mass =**	**31.025**	**lb.**	**14.073**	**kg.**
	sum mass * zbar =	**1829.501**	**lb-in**	**21075.8**	**kg-mm**
	zbar =	**58.97**	**in.**	**1497.6**	**mm**
Post-2nd burn	**sum mass =**	**19.270**	**lb.**	**8.741**	**kg.**
	sum mass * zbar =	**1139.374**	**lb-in**	**13125.6**	**kg-mm**
	zbar =	**59.13**	**in.**	**1501.6**	**mm**