



MiniSShot

ProtoSShot-M Mark I Rocket Motor

Assembly & Propellant Loading Manual

Rev. 2008/04/18

Introduction

This document describes the procedures required to assemble the *ProtoSShot-M Mark I* rocket motor and to load the propellant charges and igniter systems. The *ProtoSShot-M Mark I* motor is slated to be the propulsion unit for the *MiniSShot* vehicle.

The *ProtoSShot-M Mark I* motor is illustrated in Figure 1.

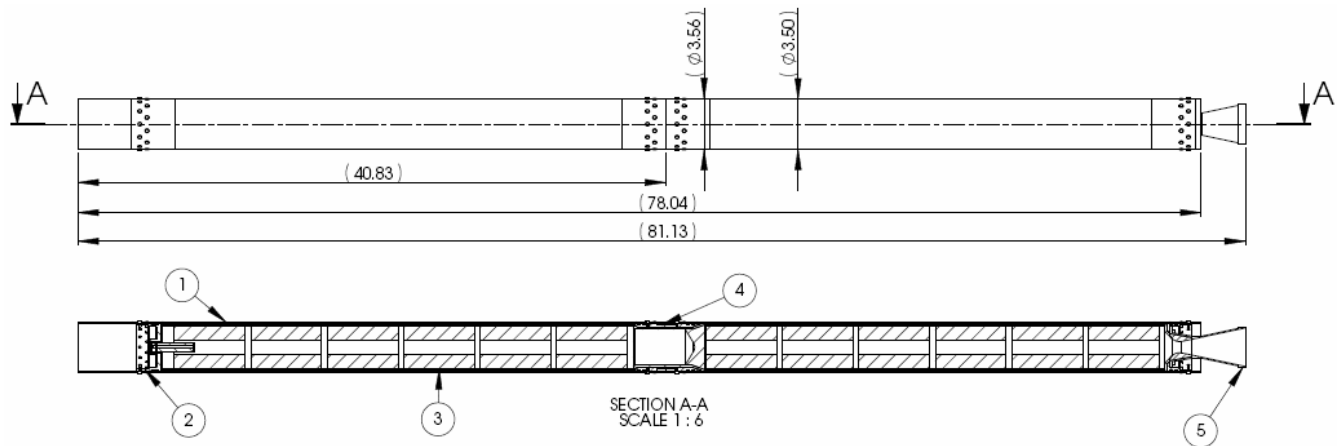
Important – Check off box on the left side upon completion of each step.

Parts listing

<u>P/N</u>	<u>Qty.</u>	<u>Description</u>
P1	1	Aft motor casing/thermal insulation assembly
P2	1	Forward motor casing/thermal insulation assembly
P3	1	Nozzle assembly
P4	1	Mid-bulkhead/Delay Plug/Burst Diaphragm assembly
P5	1	Forward bulkhead
P6	1	Pyrogen Unit
P7	1	Pyrogen grain
P8	12	Propellant segment
P9	1	Grain spacer (short piece of 3" mailing tube)
P10	8	O-ring, -234, nitrile (Buna-N)
P11	96	#8-32x1/4 custom shoulder screw
P12	a/r	Silicone grease, Dow Corning 111 or equivalent
P13	a/r	Silicone rubber sealant (type I) or RTV
P14	a/r	Lacquer thinner or acetone
P15	1	Pyrotechnic igniter
P16	a/r	Ignition Primer Slurry. Prepare by mixing 70% IPA with a blend of finely pulverized mixture of potassium nitrate and charcoal, to the mass ratio of 80/20. Slurry consistency should be that of thick paint.
P17	1	Primary Igniter containing 10 grams of CuO/Mg thermitite

Tools required

T1	Allen (hex) key, 9/64"
T2	Centre punch, tapered
T3	Snap ring pliers
T4	Wooden craft sticks
T5	Box cutter knife
T6	Grain insertion tool (3 foot long wooden dowel or cardboard tube, used to slide grain segments deep into motor casing)
T7	Two 7/16" wrenches (spanner or socket)
T8	Small paint brush



NOTES:

- 1: FORWARD MOTOR CASING ASSEMBLY
- 2: FORWARD BULKHEAD/PYROGEN ASSEMBLY
- 3: PROPELLANT GRAIN ASSEMBLY (12PL)
- 4: MID-BULKHEAD ASSEMBLY
- 5: NOZZLE ASSEMBLY

Figure 1 – Basic dimensions and components of the motor assembly

I. Priming of Propellant Segments

- 1. Prepare Ignition Primer slurry (P16) and paint onto both ends of all 12 propellant grain segments, as shown in Figure 2, using small paint brush (T8).
Optional: paint core to within 1” of each end.
- 2. Allow to dry fully prior to installation.

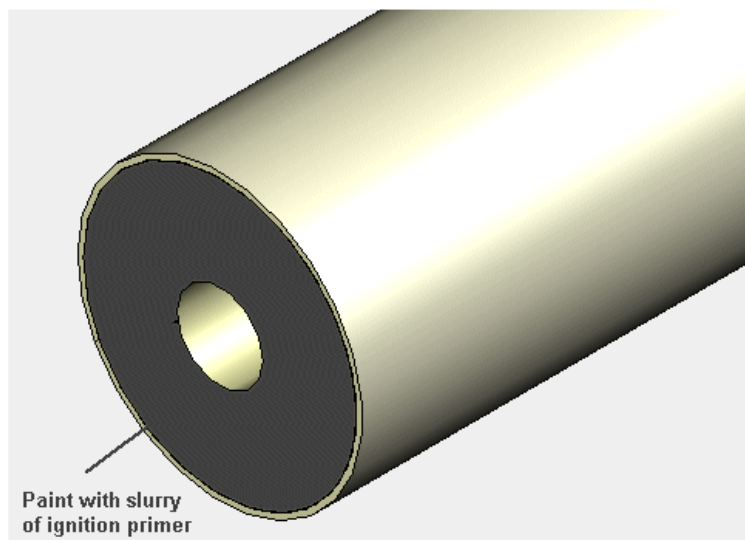


Figure 2 – Priming of propellant segments

II. Pyrogen Unit assembly procedure

1. Slip the igniter (P15) electrical leads through the two small holes in the pyrogen cap (see Fig.3), leaving approximately 2 inches of length to the igniter head.
2. Seal around the lead wires through the cap holes using J-B Weld epoxy, filling the interior cavity completely. Allow to fully cure prior to proceeding.
3. Insert pyrogen grain (P7) into pyrogen canister.
4. Insert the igniter into grain core and carefully screw pyrogen cap onto canister hand-tight.
5. Perform continuity check of igniter.
6. Strip the lead wires and shunt together.

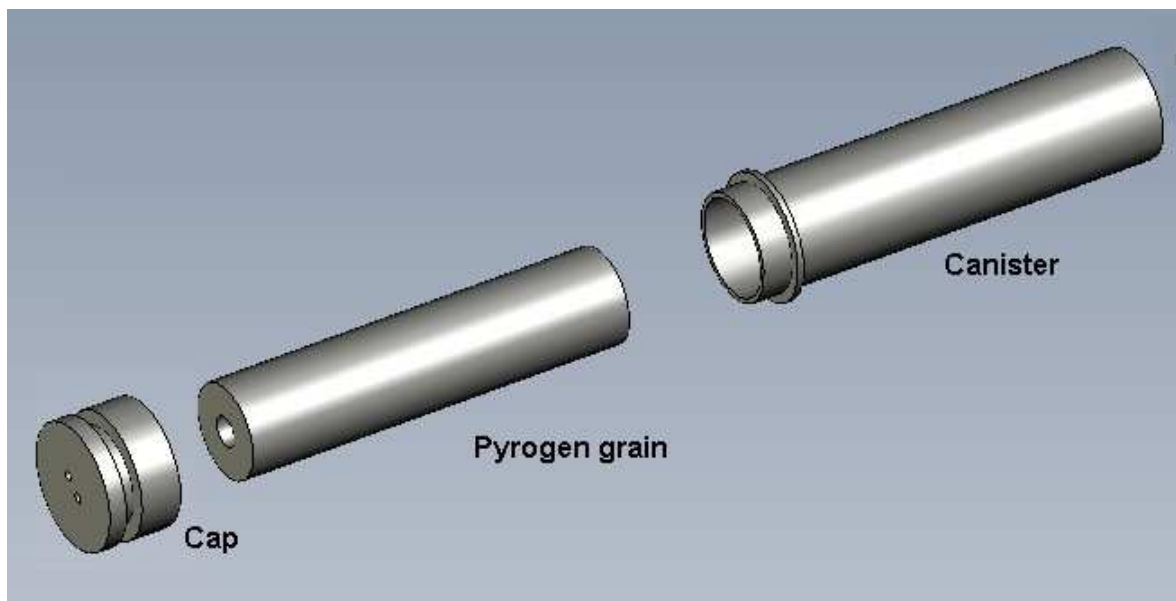


Figure 3 –Pyrogen unit – exploded view

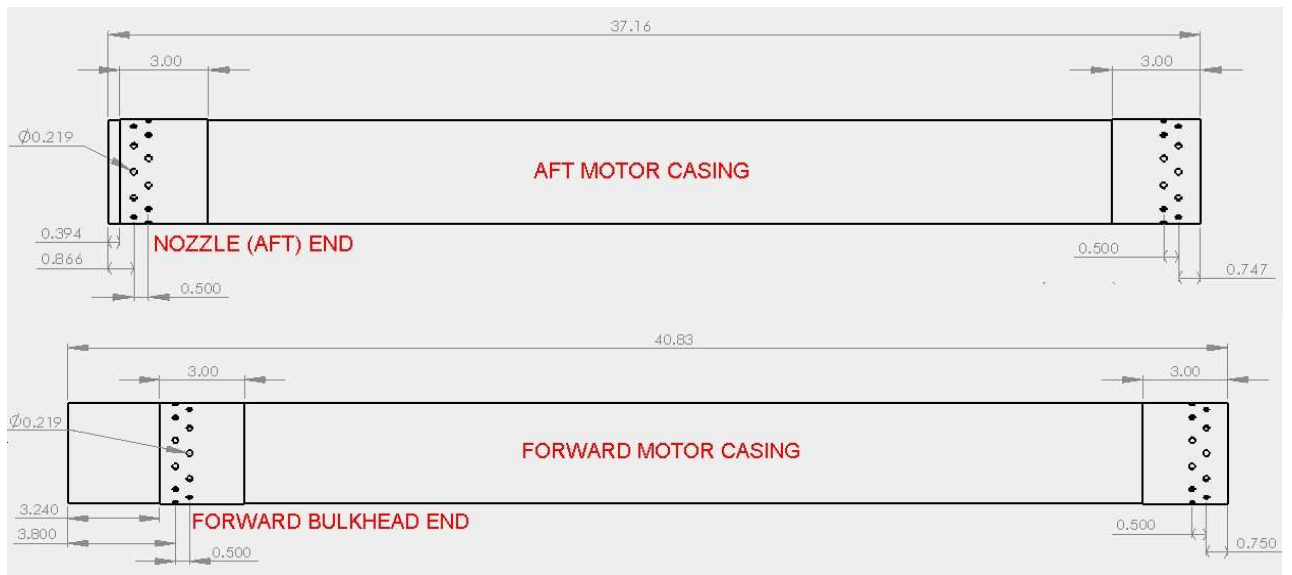


Figure 4 – Identification of Forward and Aft Motor casings

III. Installation of Nozzle Assembly into Aft Casing

1. Fill Nozzle (P3) o-ring grooves with silicone grease (P12) using a craft stick (T4). Coat two o-rings (P10) with silicone grease.
2. Install both o-rings into grooves. Wipe off excess grease.
3. Lightly coat inside of Aft Casing (P1), aft end, non-insulated portion only, with silicone grease.
4. Using lacquer thinner (P14) clean flat (ablative) surface of nozzle inlet.
5. Using a craft stick (T4), apply a thin bead of RTV or silicone rubber sealant (P13) to the flat surface of the nozzle inlet, with bead width ¼” around the perimeter, as shown in Fig.5.
6. Line up attachment holes in nozzle with attachment holes in casing and firmly push nozzle into casing. Push in far enough that holes are lined up as closely as possible.
7. Using centre punch (T2), align holes by inserting punch into hole and gently prying nozzle into aligned position. Do not use excessive force.
8. Install, but do not tighten, 24 screws (P11), using hex key (T1). DO NOT USE POWER DRIVER
9. Tighten all screws, one by one, until firmly seated. Finish by torquing hand-tight. Do not over-tighten.

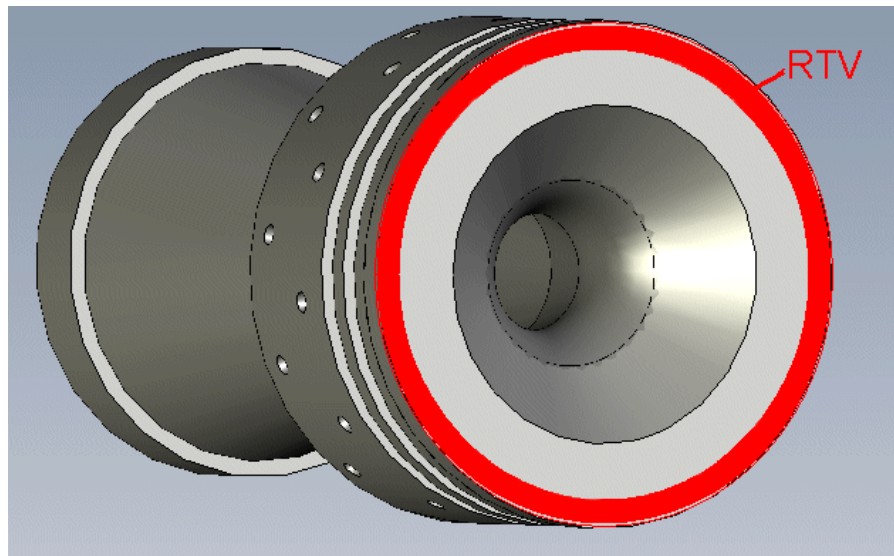


Figure 5 – RTV sealant application zone (red) on Nozzle Assembly

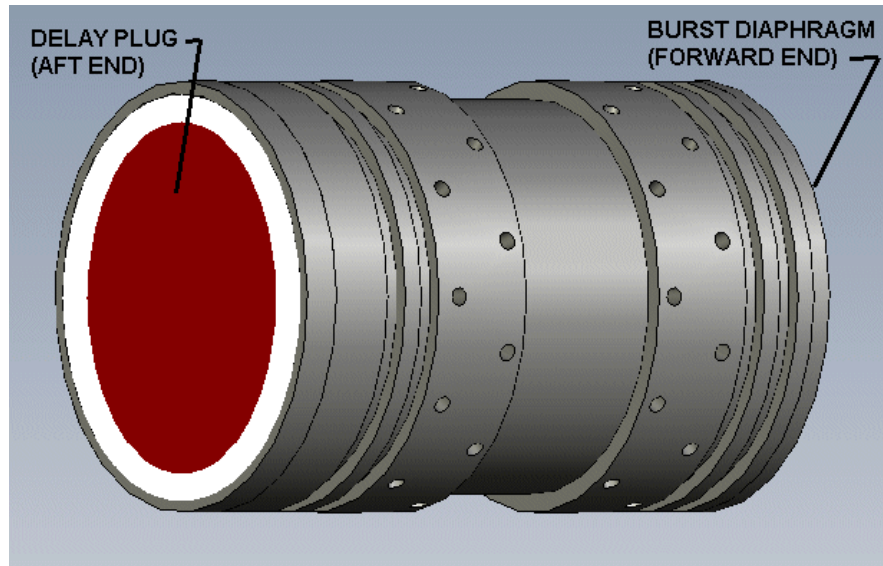


Figure 6 – Mid-bulkhead assembly, indicating Delay Plug (aft end) and Burst Diaphragm

IV. Installation of Mid-bulkhead Assembly into Forward Motor Casing.

Important: Make sure thermal sensor labels are installed on the Mid-bulkhead prior to assembly.

1. Protect Delay Plug from contamination by wrapping end of Mid-bulkhead (P4) with poly wrap held in place by elastic band.
2. Fill the two forward o-ring grooves (nearest the burst diaphragm) with silicone grease (P12) using a craft stick (T4). Coat two o-rings (P10) with silicone grease.
3. Install both o-rings into grooves. Wipe off excess grease.

- 4. Lightly coat inside of Forward Casing (P2), aft end, non-insulated portion only, with silicone grease.
- 5. Line up attachment holes in Mid-bulkhead with attachment holes in casing and firmly push Mid-bulkhead into casing. Push in far enough that holes are lined up as closely as possible.
- 6. Using centre punch (T2), align holes by inserting punch into hole and gently prying Mid-bulkhead into aligned position. Do not use excessive force.
- 7. Install, but do not tighten, 24 screws (P11), using hex key (T1). DO NOT USE POWER DRIVER
- 8. Tighten all screws, one by one, until firmly seated. Finish by torquing hand-tight. Do not over-tighten

V. Loading Propellant into Aft Motor Casing

Note: propellant grain segments are inserted into casing recessed end first.

- 1. Insert one grain segment (P8) into Aft Casing and slide fully in, using grain insertion tool (T6), until seated against nozzle.
- 2. Insert 5 additional grain segments, making sure each segment seats firmly against previously loaded segment.

VI. Installation of Mid-bulkhead/Forward Casing Assembly into loaded Aft Casing

- 1. Fill the two aft o-ring grooves of Mid-bulkhead with silicone grease (P12) using a craft stick (T4). Coat two o-rings (P10) with silicone grease.
- 2. Install both o-rings into grooves. Wipe off excess grease.
- 3. Remove protective poly bag covering Delay Plug.
- 4. Lightly coat inside of Aft Casing (non-insulated portion only) with silicone grease.
- 5. Line up attachment holes in Mid-bulkhead with attachment holes in casing and firmly push Mid-bulkhead into casing. Push in far enough that holes are lined up as closely as possible.
- 6. Using centre punch (T2), align holes by inserting punch into hole and gently prying Mid-bulkhead into aligned position. Do not use excessive force.
- 7. Install, but do not tighten, 24 screws (P11), using hex key (T1). DO NOT USE POWER DRIVER
- 8. Tighten all screws, one by one, until firmly seated. Finish by torquing hand-tight. Do not over-tighten

VII. Loading Propellant into Forward Motor Casing

Note: propellant grain segments are inserted into casing recessed end first.

- 1. Insert one grain segment (P8) into casing and slide fully in, using grain insertion tool (T6), until seated against Mid-bulkhead.

- 2. Insert 5 additional grain segments, making sure each segment seats firmly against previously loaded segment.
- 3. Measure distance from casting tube to forward lip of casing, L, as shown in Fig.7.
- 4. Cut grain spacer (P9) to required length, where length, Ls, is given by:

$$L_s = L - 5.875 \text{ inches}$$
(L is the distance in inches from the casting tube to the front of the casing, as shown in Figure 7).
- 5. Install grain spacer into casing. Trial fit Forward Bulkhead to ensure spacer is not too long. Trim as needed.

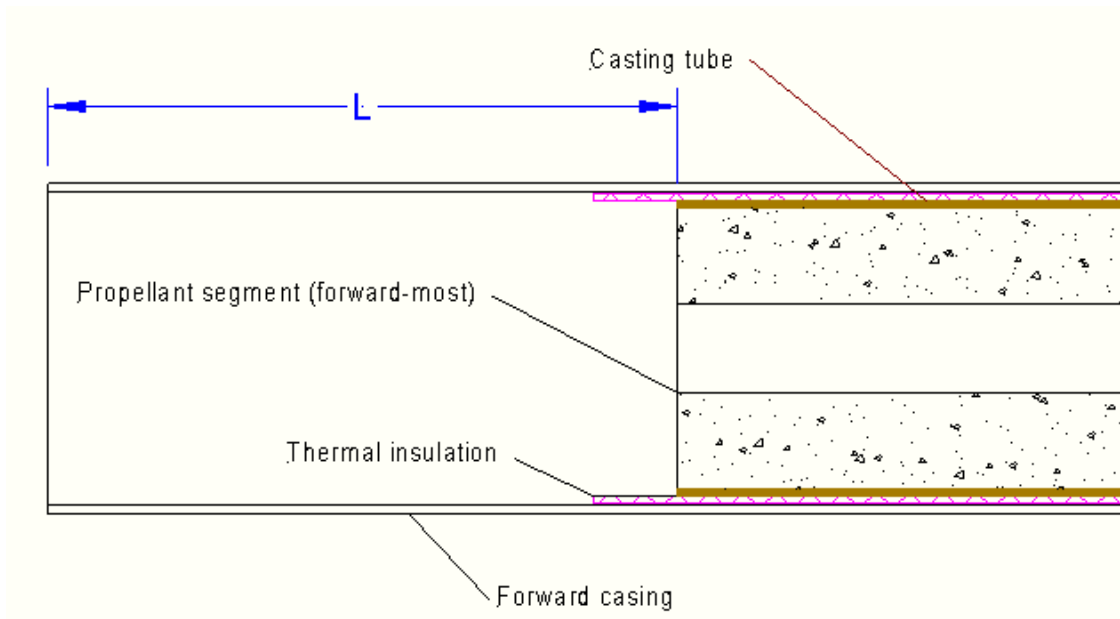


Figure 7 – Definition of dimension “L” needed to determine spacer sizing.

VIII. Installation of Forward Bulkhead into loaded Forward Motor Casing

- 1. Using a pair of 7/16” wrenches (T7), tighten the pressure port fitting securely to the Forward Bulkhead. Make certain both copper washers are installed, one on each side of bulkhead web.
- 2. Fill the two o-ring grooves of the Forward Bulkhead (P5) with silicone grease (P12) using a craft stick (T4). Coat two o-rings (P10) with silicone grease.
- 3. Install both o-rings into grooves. Wipe off excess grease.
- 4. Lightly coat inside of Forward Casing (non-insulated portion only) with silicone grease.
- 5. Line up attachment holes in Forward Bulkhead with attachment holes in casing and firmly push bulkhead into casing. Push in far enough that holes are lined up as closely as possible.
- 6. Using centre punch (T2), align holes by inserting punch into hole and gently prying bulkhead into aligned position. Do not use excessive force.

- 7. Install, but do not tighten, 24 screws (P11), using hex key (T1). DO NOT USE POWER DRIVER
- 8. Tighten all screws, one by one, until firmly seated. Finish by torquing hand-tight. Do not over-tighten.

IX. Handling and Storage

- 1. Tape the igniter leads to the sides of the casing to prevent inadvertent snagging.
- 2. Seal the nozzle to avoid moisture ingress.
- 3. Seal the opening in the Forward Bulkhead for the Pyrogen unit with aluminum tape.

Pre-Firing Procedures

X. Installation of Pyrogen Unit into Forward Bulkhead

- 1. Fill Pyrogen cap o-ring groove with silicone grease (P12) and coat o-ring with silicone grease.
- 2. Install o-ring into cap groove.
- 3. Lightly coat Pyrogen receptacle in Forward Bulkhead (P5) with silicone grease.
- 4. Slide Pyrogen Unit into receptacle in Forward Bulkhead.
- 5. Using Snap Ring pliers (T3), secure Pyrogen Unit into Forward Bulkhead with snap ring .
Ensure snap ring is fully engaged into groove.

XI. Installation of Primary Igniter into Aft Motor Casing

- 1. Stretch out Primary Igniter (P17) leads and place a piece of masking tape on the leads (as a marker), at a distance of 38 inches from the igniter head.
- 2. Insert Primary Igniter through nozzle opening and drop or carefully push igniter inward until the piece of masking tape is at the nozzle exit plane. This indicates that the igniter head is all the way to the front of the casing.
- 3. Perform continuity check of igniter.
- 4. Tape the igniter leads to the side of the nozzle or motor casing to prevent accidental snagging.