

**Lecture 9: Some Examples of Small Solid  
 Propellant Rockets for In-space Propulsion**

The STAR 13B incorporates the lightweight case developed for the STAR 13 with the propellant and nozzle design of the earlier TE-M-516 apogee motor. The motor case has been stretched 2.2 inches to provide for increased propellant loading. The motor has been used to adjust orbit inclination of a satellite from a Delta launch.

**MOTOR PERFORMANCE (70 °F Vacuum)**

Burn Time/Action Time, sec	14.8/16.1
Ignition Delay Time, sec	0.02
Burn Time Average Chamber Pressure, psia	823
Action Time Average Chamber Pressure, psia	787
Maximum Chamber Pressure, psia	935
Total Impulse, lbf-sec	26,040
Propellant: Specific Impulse, lbf-sec/lbm	286.6
Effective Specific Impulse, lbf-sec/lbm	285.7
Burn Time Average Thrust, lbf	1708
Action Time Average Thrust, lbf	1577
Maximum Thrust, lbf	2160

<b>SPIN CAPABILITY, rpm</b>	120
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**CASE**

Material	6Al-4V Titanium
Minimum Ultimate Strength, psi	165,000
Minimum Yield Strength, psi	152,000
Hydrostatic Test Pressure, psi	1330
Yield Pressure, psi	1394
Hydrostatic Test Pressure/Maximum Pressure	1.05
Nominal Thickness, In.	0.035

**NOZZLE**

Exit Cone Material	Vitreous Silica Phenolic
Throat Insert Material	ATJ Graphite
Initial Throat Area, in <sup>2</sup>	1.14
Exit Diameter, In.	8.02
Expansion Ratio, Initial/Average	49.8/41.0
Expansion Cone Half Angle, deg	17
Type	Fixed
Number of Nozzles	1

**LINER**

Type	TL-H-304
Density, lbm/ in. <sup>3</sup>	0.045

## IGNITION TRAIN

Components	S&A/ETA/TBI/pyrogen igniter
Minimum Firing Current per Detonator, amperes	5.0
Circuit Resistance per Detonator, ohms	1.0
No. of Detonators and TBIs	2
Squib or TBI compatible	

## WEIGHTS, lbm

Total Loaded	103.7
Propellant	90.9
Case Assembly	5.64
Nozzle Assembly	3.72
Igniter Assembly	0.68
Internal Insulation	2.34
Liner	0.14
Miscellaneous	0.28
Total Inert (excluding igniter propellant)	12.80
Burnout	12.30
Propellant Mass Fraction	0.87

## TEMPERATURE LIMITS

Operation	40 to +110°F
Storage	40 to +110°F

## PROPELLANT

Propellant Designation and Formula	TP-H-3082
AP-70%	
Al-16%	
CTPB Binder-14%	

## PROPELLANT CONFIGURATION

Type	Internal burning, 8-point star
Web, In.	4.187
Web Fraction, %	62
Silver Fraction, %	2
Propellant Volume, in. <sup>3</sup>	1446
Volumetric Loading Density	92
Web Average Burning Surface Area, in. <sup>2</sup>	345
Initial Surface to Throat Area Ratio	316

## PROPELLANT CHARACTERISTICS

Burn Rate at 1000 psia, in./sec	0.301
Burn rate Exponent	0.31
Density, lbm/in. <sup>3</sup>	0.0628
Temperature Coefficient of Pressure, %/°F	0.10
Characteristic Exhaust Velocity, ft/sec	5025
Adiabatic Flame Temperature, °F	5662

Effective Ratio of Specific Heats (chamber)  
(Nozzle Exit)

1.16  
1.21

**CURRENT STATUS**

Production

BC1355B 4/91

