

CHAPTER 3

PERFORMANCE

The launch performance given in this chapter is based on the following assumptions:

- Taking into account the relevant range safety limitations and ground tracking requirements;
- Mass of the payload adapter and the separation system are included in LV mass;
- Standard fairing (3.35 m in diameter, 8.368 m in length) is adopted;
- At fairing jettisoning, the aerodynamic heating being less than 1135 W/m^2 ;
- The total impulse of CTS Solid Rocket Motor can be adjusted according to different mission requirements.
- Orbital altitude values given with respect to a mean radius of equator of 6378.140 km.

The two-stage LM-2C is mainly used for conducting LEO ($h < 500 \text{ km}$) missions and the LM-2C/CTS for circular LEO ($h \geq 500 \text{ km}$) and SSO missions. LM-2C takes JSJC as its main launch site, and it can also be launched from XSLC and TSLC. In this Chapter, the launch capabilities of LM-2C launching from JSJC and XSLC are introduced. The launch capabilities vary with different orbital altitudes and inclinations.

3.1 LM-2C Mission Descriptions

3.1.1 Flight Sequence

The typical flight sequence of LM-2C is shown in **Table 3-1** and **Figure 3-1**.

Table 3-1 LM-2C Flight Sequence

Events	Two-stage LM-2C Flight Time (s)	LM-2C/CTS Flight Time (s)
Liftoff	0.000	0.000
Pitch Over	10.000	10.000
Stage-1 Shutdown	120.270	120.270
Stage-1/Stage-2 Separation	121.770	121.770
Fairing Jettisoning	231.670	231.670

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Stage-2 Main Engine Shutdown	305.770	301.184
Stage-2 Vernier Engine Shutdown	566.234	613.333
Stage-2/CTS Separation	/	616.333
CTS Solid Rocket Motor Ignition	/	2888.347
Beginning of Terminal Velocity Adjustment	/	2928.347
SC/LV Separation	569.234	3013.347
CTS Deorbit	/	3213.347

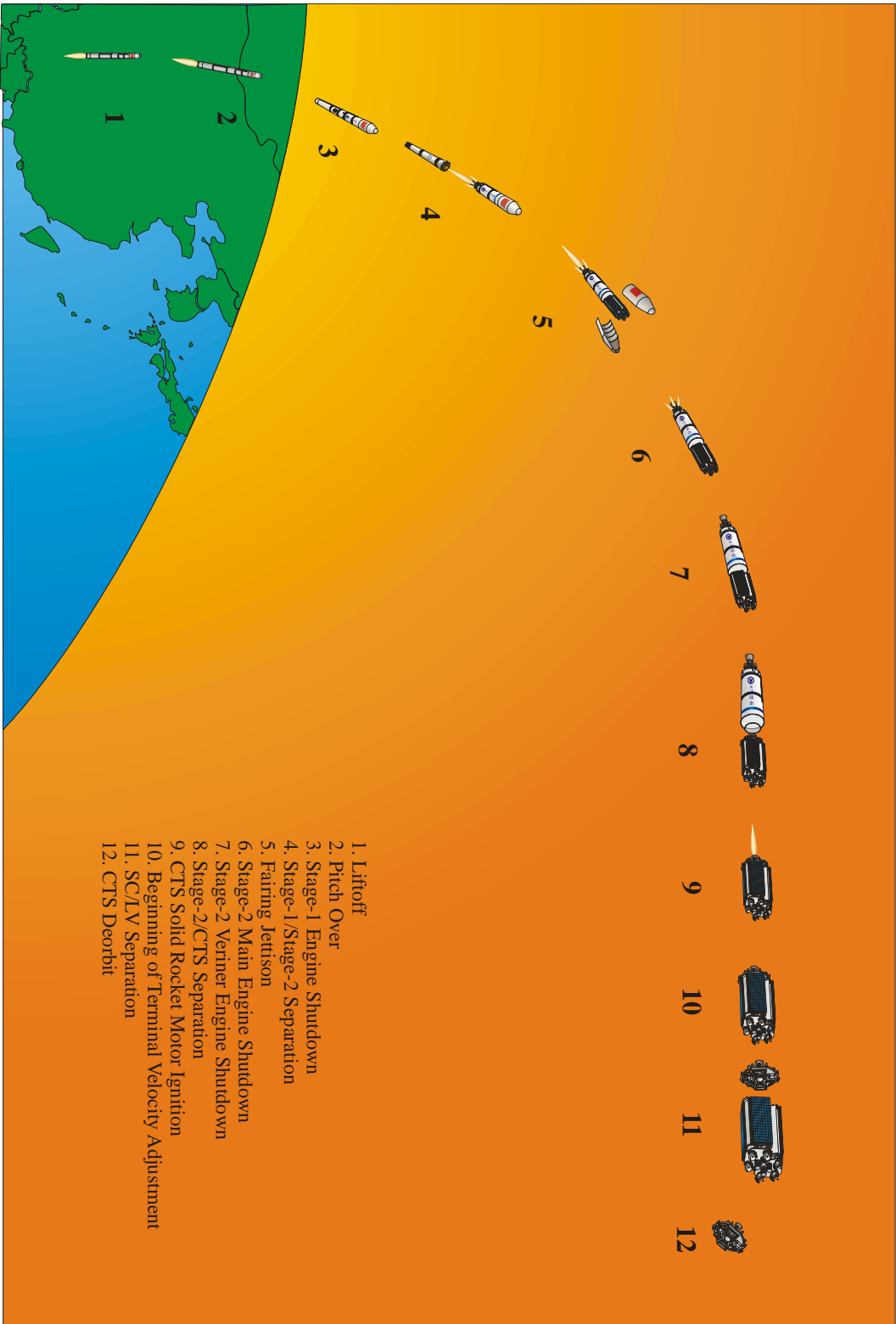


Figure 3-1 LM-2C/CTS Flight Sequence

3.1.2 LM-2C/CTS Characteristic Parameters

The characteristic parameters of typical LM-2C/CTS trajectory are shown in **Table 3-2**. The flight acceleration, velocity, Mach numbers and altitude vs. time are shown in **Figure 3-2a&b**.

Table 3-2 Characteristic Parameters of Typical Trajectory

Event	Relative Velocity (m/s)	Flight Altitude (km)	Ground Distance (km)	Ballistic Inclination (°)	SC projection Latitude (°)	SC projection Longitude(°)
Liftoff	0.2	1.452	0	90	38.661	111.608
Stage-1 Shutdown	2035.853	47.052	61.755	22.765	38.106	111.633
Stage-1/Stage-2 Separation	2043.777	48.257	64.549	22.403	38.081	111.635
Fairing Jettisoning	3698.167	117.618	352.768	4.263	35.490	111.729
Stage-2 Main Engine Shutdown	6379.424	146.895	679.624	-2.540	32.551	111.813
Stage-2 Vernier Engine Shutdown	7917.684	181.142	2825.723	-25.629	13.252	112.076
Stage-2/CTS Separation	7918.657	181.104	2848.800	-25.829	13.045	112.077
CTS SRM Ignition	7402.700	637.804	18860.013	-173.727	-44.220	-80.123
Terminal Velocity Adjustment Ending	7512.356	639.455	18971.228	-177.295	-41.780	-80.001
SC/LV Separation	7520.725	637.611	18983.402	177.366	-36.557	-79.808

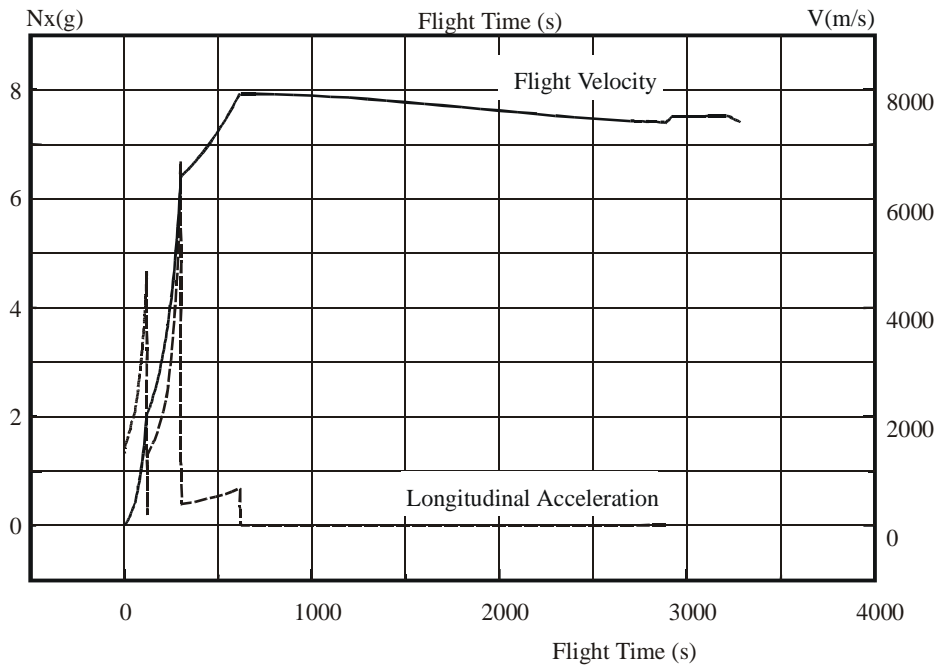


Figure 3-2a LM-2C/CTS Flight Acceleration and Flight Velocity vs. Flight Time

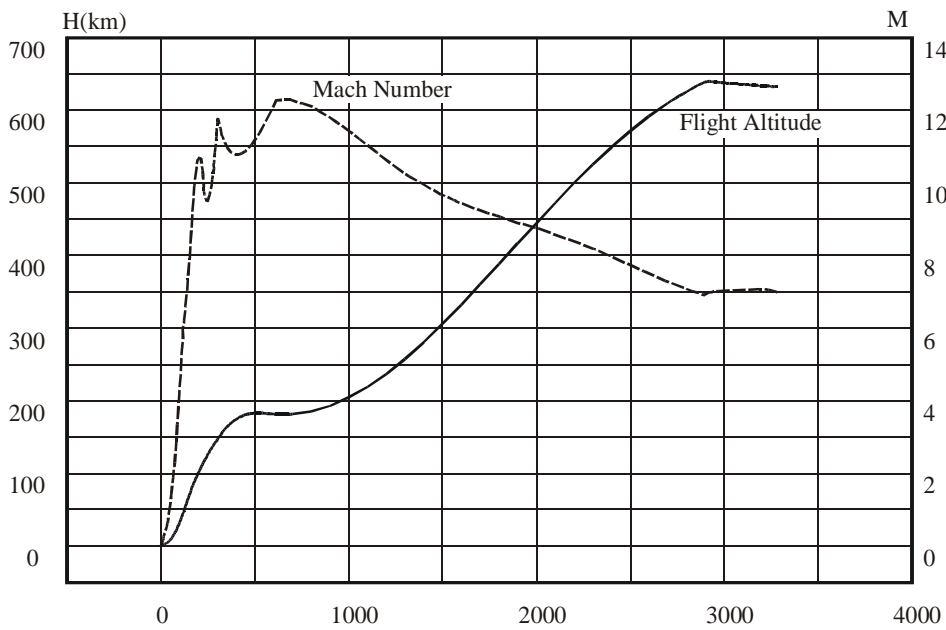


Figure 3-2b LM-2C/CTS Flight Altitude and Mach Numbers vs. Flight Time

3.2 Launch Capacities

3.2.1 Basic Information on Launch Sites

- **Jiuquan Satellite Launch Center (JSLC)**

Two-stage LM-2C and LM-2C/CTS conduct LEO and SSO missions from Jiuquan Satellite Launch Center (JSLC), which is located in Gansu Province, China. The geographic coordinates are listed as follows:

Latitude:	40.96°N
Longitude:	100.29°E
Elevation:	1072m

- **Xichang Satellite Launch Center (XSLC)**

Two-stage LM-2C and LM-2C/CTS conduct LEO missions from Xichang Satellite Launch Center (XSLC), which is located in Sichuan Province, China. The geographic coordinates are listed as follows:

Latitude:	28.2°N
Longitude:	102.02°E
Elevation:	1826m

3.2.2 Two-stage LM-2C Mission Performance

The launch capacity of Two-stage LM-2C for typical LEO mission ($h=200\text{km}$, $i=63^\circ$) is 3366kg. The different LEO launch capabilities vs. different inclinations and apogee altitudes are shown in **Figure 3-3a,b,c&d**.

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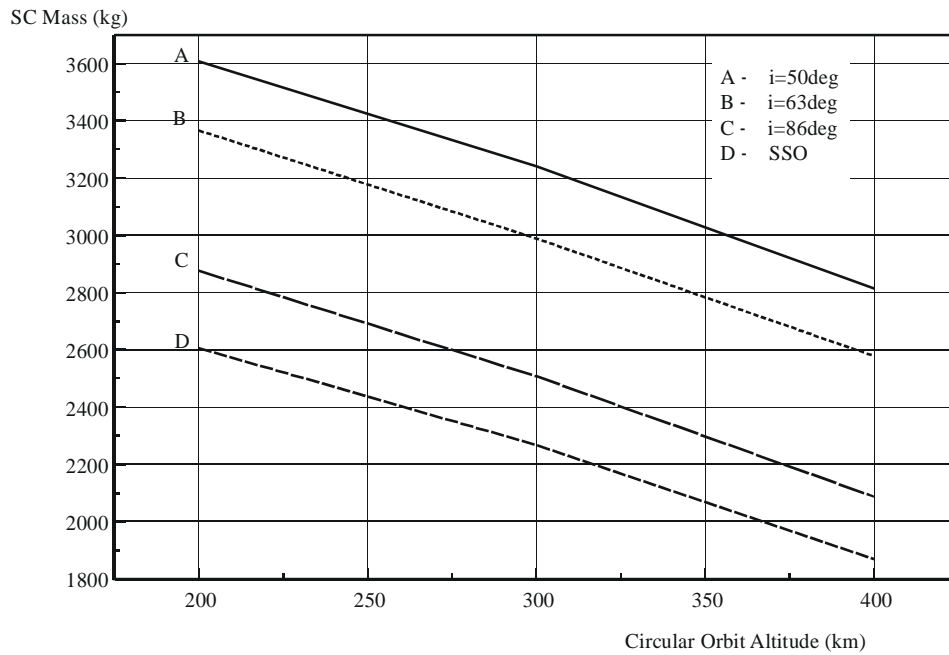


Figure 3-3a Two-stage LM-2C's Capability for Circular Orbit Missions (From JSLC)

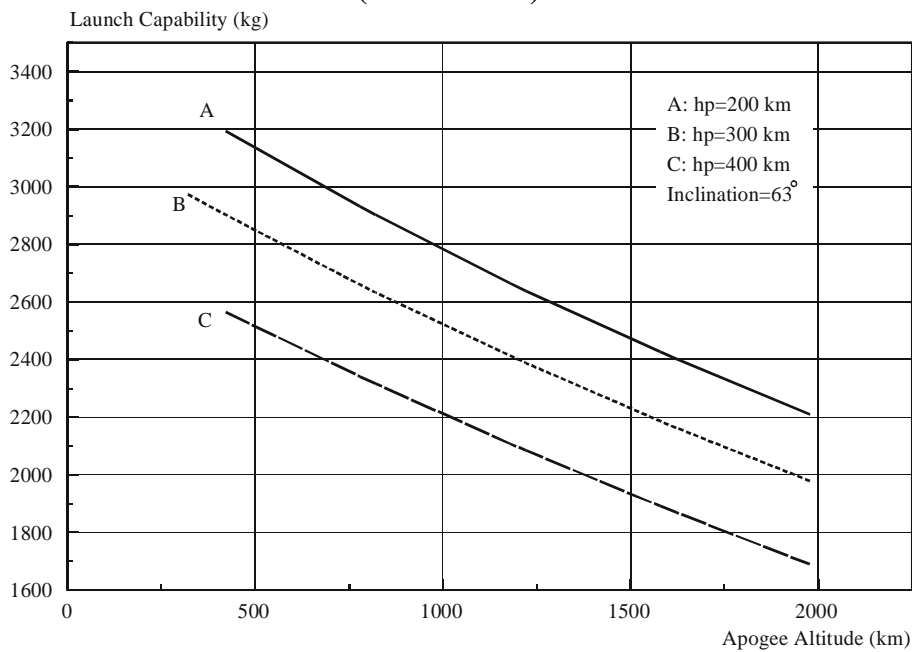


Figure 3-3b Two-stage LM-2C's Capability for Elliptical Orbit Missions (From JSLC)

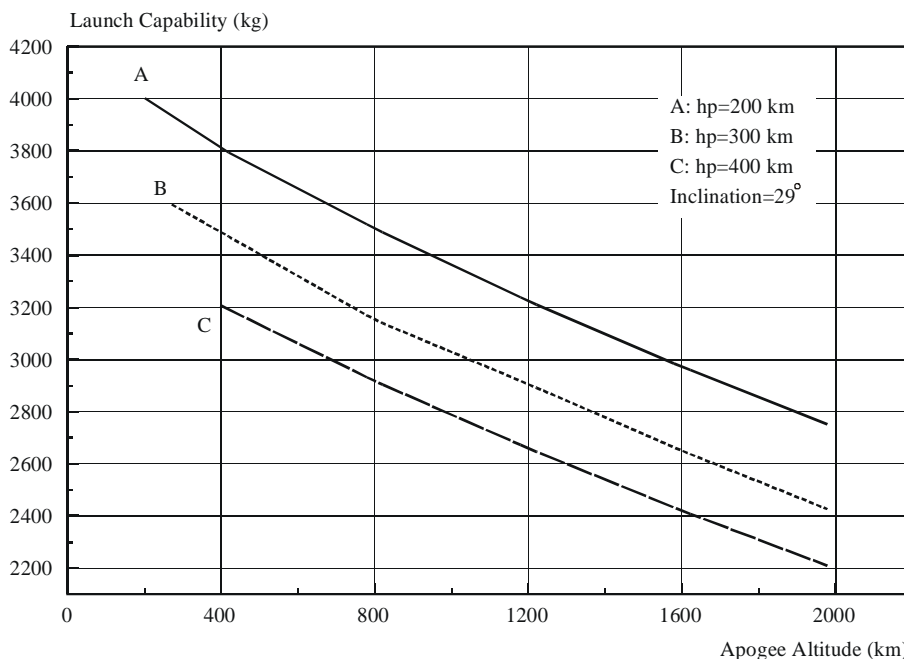


Figure 3-3c Two-stage LM-2C's Capability for Elliptical Orbit Missions (From XSLC)

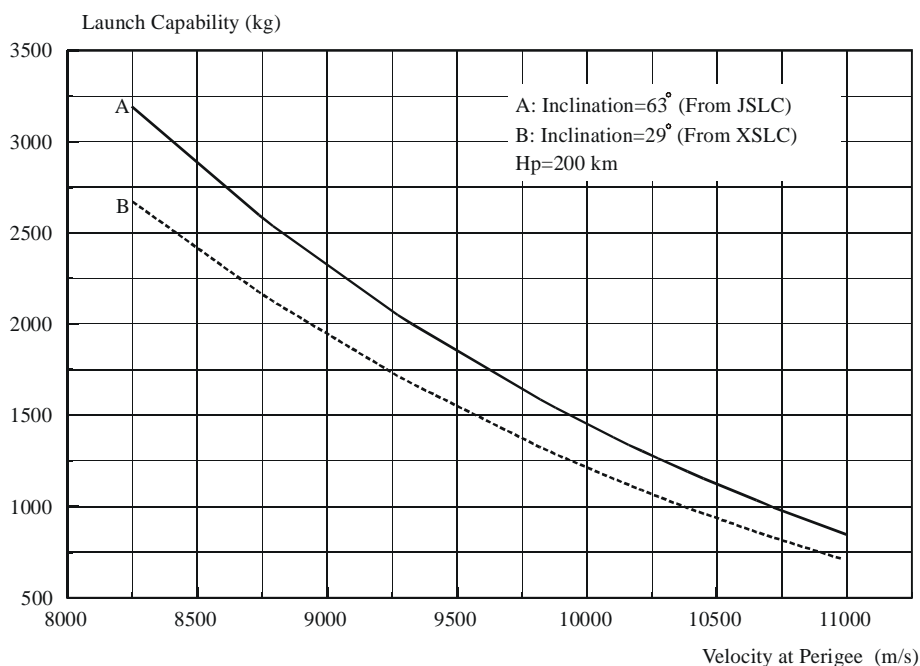


Figure 3-3d LM-2C's Capability for Large Elliptical Orbit Missions

Note: For this kind of mission, LM-2C works as follows: After Two-stage LM-2C reach the parking orbit (a LEO), it will release a solid upper stage and spin it up

according to required direction. Then the upper stage will go into the large elliptical transit orbit by ignition at the pre-determined time. The method is suitable for GTO or Earth escape missions. The solid upper stage for orbit maneuvering can be made according to user's specific requirements.

3.2.3 LM-2C/CTS Mission Performance

The launch capacity of LM-2C/CTS for typical LEO mission (h=500 km, i=50°) is 3000 kg. The different LEO and SSO launch capabilities vs. different inclinations and apogee altitudes are shown in **Figure 3-4a&b**.

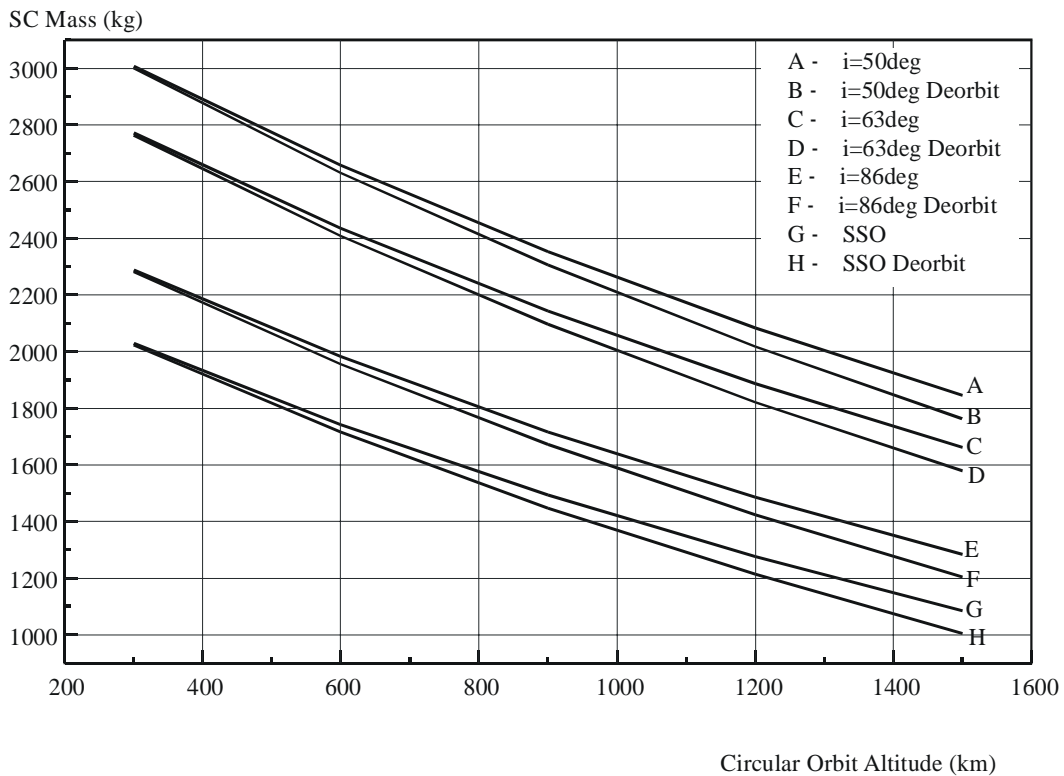


Figure 3-4a LM-2C/CTS's Capability for Circular Orbit Missions (From JSLC)

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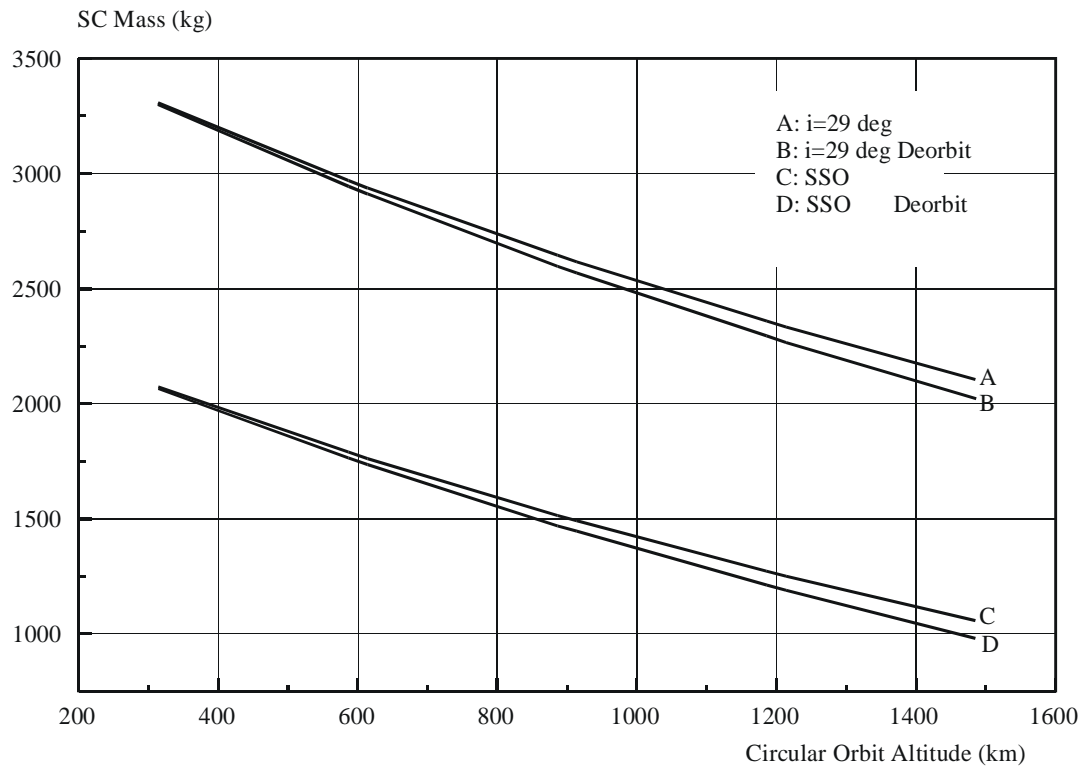


Figure 3-4b LM-2C/CTS's Capability for Circular Orbit Missions (From XSLC)

3.3 Injection Accuracy

3.3.1 Two-stage LM-2C Injection Accuracy

The injection accuracy is different for the different missions. The injection accuracy for elliptical LEO (hp=200km, ha=400km) mission is shown in **Table 3-3** and **Table 3-4**.

**Table 3-3 Injection Accuracy for LEO Mission
(hp=200km, ha=400km)**

Symbol	Parameters	Deviation (1σ)
Δa	Semi-major Axis	1.1 km
Δe	Eccentricity	0.00022
Δi	Inclination	0.045 deg.
$\Delta \Omega$	Right Ascension of Ascending Node	0.055 deg.
$\Delta \omega$	Perigee Argument	1.67 deg.

**Table 3-4 Covariance Matrix of Injection for LEO Mission
(hp=200km, ha=400km)**

	a	e	i		
a	1.210	1.154E-4	-8.821E-3	2.202E-2	6.319E-1
e		4.840E-8	-3.086E-6	9.622E-6	1.564E-4
i			2.025E-3	-3.044E-4	7.823E-3
				3.025E-3	2.172E-2
					2.789

3.3.2 LM-2C/CTS Injection Accuracy

The injection accuracy for the circular orbit mission (h=630km) is shown in **Table 3-5**.

Table 3-5 Injection Accuracy for Circular Orbit Mission (h=630km)

Symbol	Parameters	Deviation (1σ)
Δh	Orbital Altitude	6 km
Δi	Inclination	0.05 deg.
$\Delta \Omega$	Right Ascension of Ascending Node	0.06 deg.

3.4 Separation Accuracy

3.4.1 Two-stage LM-2C Separation Accuracy

The separation accuracy of Two-stage LM-2C is shown in **Table 3-6**.

Table 3-6 Two-stage LM-2C Separation Accuracy (1σ)

Items	Separation Accuracy
Roll Angular Rates Ω_x	$<0.5^\circ/s$
Yaw Angular Rates Ω_y	$<1.1^\circ/s$
Pitch Angular Rates Ω_z	$<1.1^\circ/s$
Pitch	$<3.2^\circ$
Yaw	$<3.2^\circ$
Roll	$<1.5^\circ$

3.4.2 LM-2C/CTS Separation Accuracy

The separation accuracy of LM-2C/CTS is shown in **Table 3-7**.

Table 3-7 LM-2C/CTS Separation Accuracy (1σ)

Items	Separation Accuracy
Roll Angular Rates Ω_x	$<0.3^\circ/s$
Yaw Angular Rates Ω_y	$<0.3^\circ/s$
Pitch Angular Rates Ω_z	$<0.3^\circ/s$
Pitch	$<0.6^\circ$
Yaw	$<0.6^\circ$
Roll	$<0.6^\circ$

3.5 Launch Windows

LM-2C adopts automatic timing ignition, and it can be launched in zero-launch window.