

# PSLV-C32

## IRNSS-1F

# PSLV-C32



PSLV-C32 at the Second Launch Pad

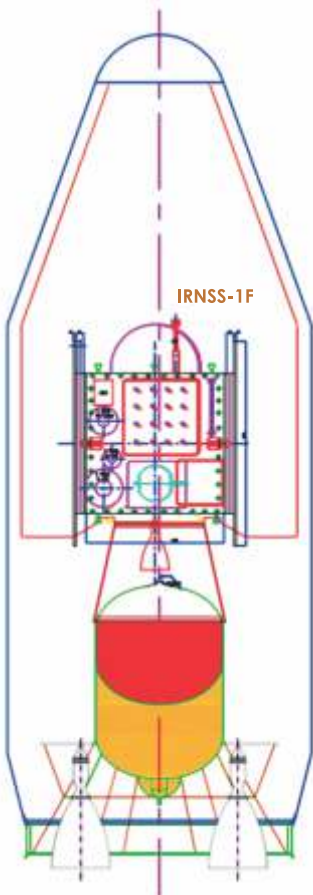
Polar Satellite Launch Vehicle, in its thirty fourth flight (PSLV-C32), will launch IRNSS-1F, the sixth satellite of the Indian Regional Navigation Satellite System (IRNSS). The launch will take place from the Second Launch Pad (SLP) of Satish Dhawan Space Centre (SDSC) SHAR, Sriharikota. As in the previous five launches of IRNSS satellites, PSLV-C32 will use 'XL' version of PSLV. This is the twelfth time 'XL' configuration is being flown, earlier eleven being PSLV-C11/Chandrayaan-1, PSLV-C17/GSAT-12, PSLV-C19/RISAT-1, PSLV-C22/IRNSS-1A, PSLV-C25/Mars Orbiter Spacecraft, PSLV-C24/IRNSS-1B, PSLV-C26/IRNSS-1C, PSLV-C27/IRNSS-1D, PSLV-C28/DMC-3, PSLV-C30/ASTROSAT and PSLV-C31/IRNSS-1E missions.

## PSLV-C32 at a glance (Vehicle lift-off Mass: 320 tonne Height: 44.4 m)

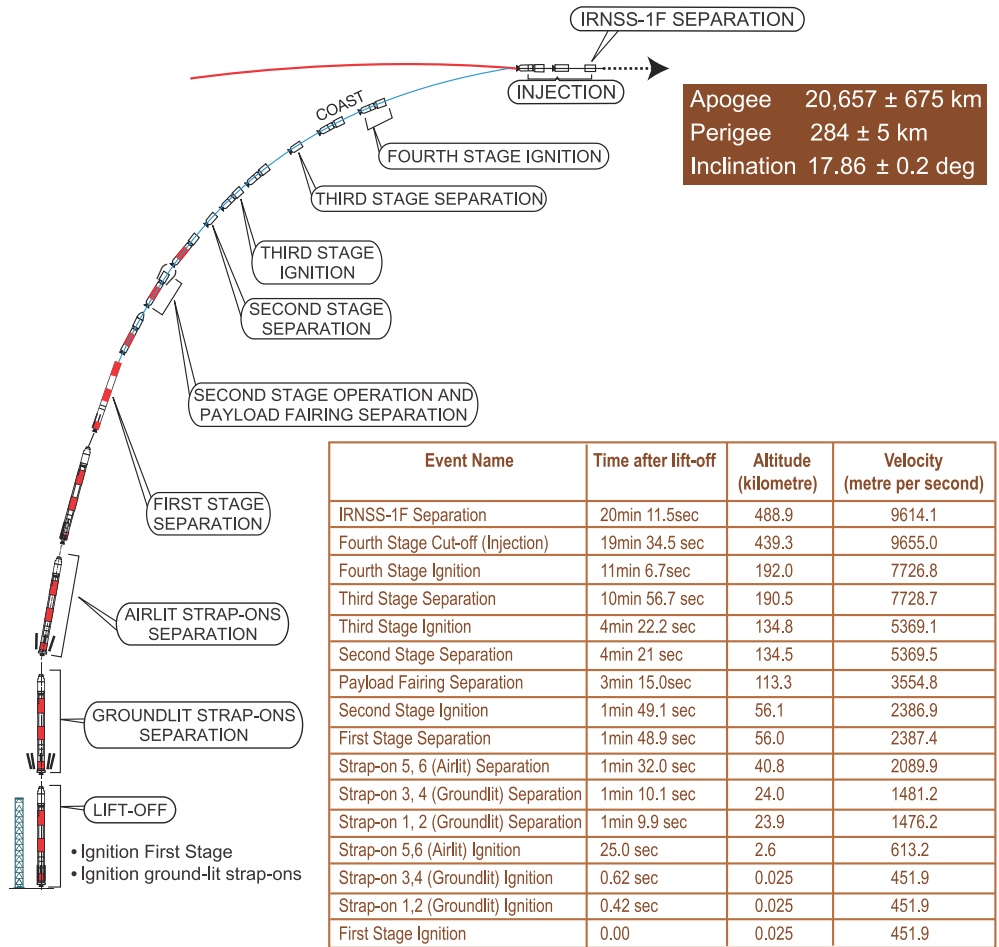
	Stage-1	Stage-2	Stage-3	Stage-4
Nomenclature	Core Stage PS1 + 6 Strap-on Motors	PS2	PS3	PS4
Propellant	Solid (HTPB based)	Liquid (UH25 + N <sub>2</sub> O <sub>4</sub> )	Solid (HTPB based)	Liquid (MMH + MON-3)
Propellant Mass (T)	138.2 (Core), 6 x 12.2 (Strap-on)	42.0	7.6	2.5
Stage Dia (m)	2.8 (Core), 1 (Strap-on)	2.8	2.0	1.3
Stage Length (m)	20 (Core), 12 (Strap-on)	12.8	3.6	3.0

- HTPB : Hydroxyl Terminated Poly Butadiene
- UH25 : Unsymmetrical Dimethyl Hydrazine + 25% Hydrazine Hydrate
- N<sub>2</sub>O<sub>4</sub> : Nitrogen Tetroxide
- MMH : Mono Methyl Hydrazine, MON-3: Mixed Oxides of Nitrogen

# PSLV-C32



**IRNSS-1F in PSLV-C32 Envelope**



## PSLV-C32 Typical Flight Profile



**Assembly of PSLV-C32 First stage in progress**



**Hoisting of PSLV-C32 Second stage during vehicle integration**



# IRNSS-1F



**IRNSS-1F in Clean Room during its integration**

thermal control schemes have been designed and implemented for some of the critical elements such as atomic clocks. The Attitude and Orbit Control System (AOCS) of IRNSS-1F maintains the satellite's orientation with the help of reaction wheels, magnetic torquers and thrusters. Its propulsion system consists of a Liquid Apogee Motor (LAM) and thrusters.

IRNSS-1F will be launched into a sub Geosynchronous Transfer Orbit (sub GTO) with a 284 km perigee (nearest point to Earth) and 20,657 km apogee (farthest point to Earth) with an inclination of 17.86 deg with respect to the equatorial plane.

IRNSS-1F is the sixth navigation satellite of the seven satellites constituting the IRNSS space segment. Its predecessors, IRNSS-1A, 1B, 1C, 1D and 1E were launched by PSLV-C22, PSLV-C24, PSLV-C26, PSLV-C27 and PSLV-C31 in July 2013, April 2014, October 2014, March 2015 and January 2016 respectively. IRNSS-1F has a lift-off mass of 1425 kg. The configuration of IRNSS-1F is similar to that of IRNSS-1A, 1B, 1C, 1D and 1E.

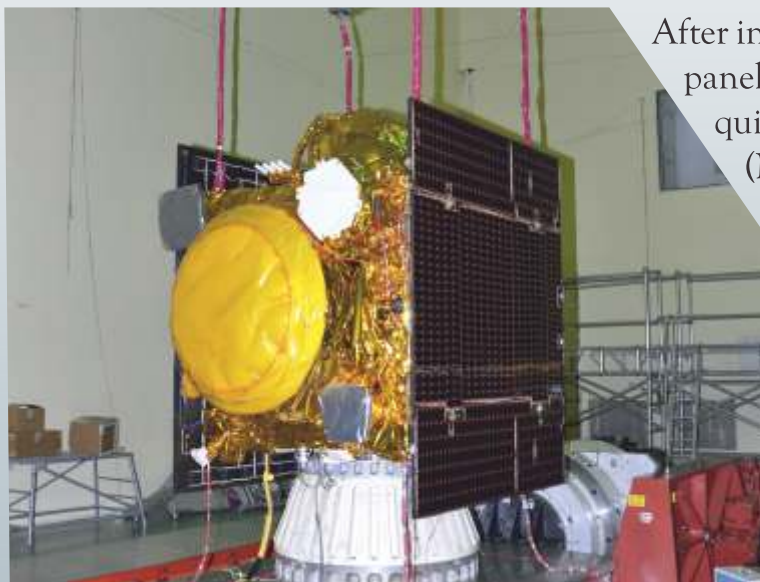
The two solar arrays of IRNSS-1F consisting of Ultra Triple Junction solar cells generate about 1660 Watts of electrical power. Sun and Star sensors as well as gyroscopes provide orientation

reference

for the satellite. Special



**IRNSS-1F being loaded into thermo-vacuum chamber**

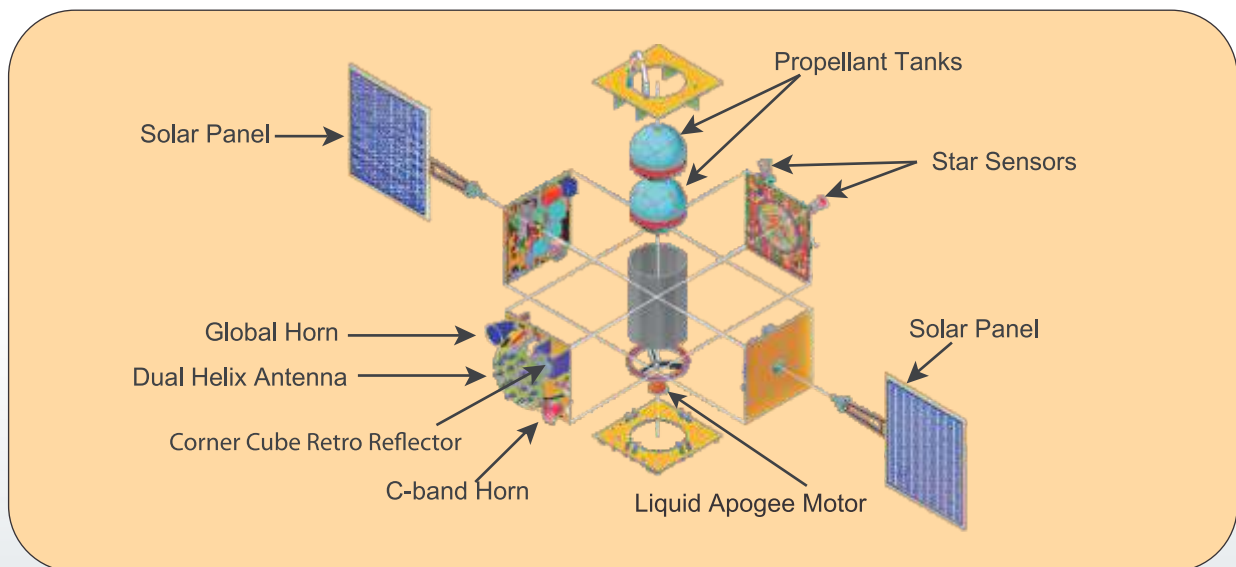


**IRNSS-1F being readied for vibration test**

After injection into this preliminary orbit, the two solar panels of IRNSS-1F are automatically deployed in quick succession and the Master Control Facility (MCF) at Hassan takes control of the satellite and performs the initial orbit raising manoeuvres consisting of one manoeuvre at perigee (nearest point to earth) and three at apogee (farthest point to earth). For these manoeuvres, the Liquid Apogee Motor (LAM) of the satellite is used, thereby finally placing it in the geostationary orbit at 32.5 deg E.

## IRNSS-1F Salient features

<b>ORBIT</b>	Geostationary, at 32.5 deg East longitude
<b>LIFT-OFF MASS</b>	1425 kg
<b>DRY MASS</b>	598 kg
<b>PHYSICAL DIMENSIONS</b>	1.58 metre x 1.50 metre x 1.50 metre
<b>POWER</b>	Two solar panels generating 1660 W, one Lithium-ion battery of 90 Ampere-Hour capacity
<b>PROPULSION</b>	440 Newton Liquid Apogee Motor, twelve 22 Newton Thrusters
<b>CONTROL SYSTEM</b>	Zero momentum system, orientation input from Sun & Star Sensors and Gyroscopes; Reaction Wheels, Magnetic Torquers and 22 Newton thrusters as actuators
<b>MISSION LIFE</b>	12 years



**IRNSS -1F Disassembled View**

## PAYLOADS:

IRNSS -1F carries two types of payloads – navigation payload and ranging payload. The navigation payload of IRNSS-1F will transmit navigation service signals to the users. This payload will be operating in L5 band (1176.45 MHz) and S band (2492.028 MHz). A highly accurate Rubidium atomic clock is part of the navigation payload of the satellite. The ranging payload of IRNSS-1F consists of a C-band transponder which facilitates accurate determination of the range of the satellite. IRNSS-1F also carries Corner Cube Retro Reflectors for laser ranging.





# IRNSS Overview:

IRNSS is an independent regional navigation satellite system being developed by India. It is designed to provide accurate position information service to users in India as well as the region extending up to 1500 km from its boundary, which is the primary service area of IRNSS. The Extended Service Area lies between primary service area and area enclosed by the rectangle from Latitude 30 deg South to 50 deg North, Longitude 30 deg East to 130 deg East. IRNSS will provide two types of services, namely, Standard Positioning Service (SPS), which is provided to all the users and Restricted Service (RS), which is an encrypted service provided only to the authorised users. The IRNSS System is expected to provide a position accuracy of better than 20 m in the primary service area.

IRNSS comprises of a space segment and a ground segment. The IRNSS space segment consists of seven satellites, with three satellites in geostationary orbit and four satellites in inclined geosynchronous orbit. IRNSS-1A, 1B, 1C, 1D and 1E, the first five satellites of the IRNSS constellation, have already started functioning from their designated orbital slots after extensive on-orbit test and evaluation to confirm their satisfactory performance.

The IRNSS Signal-in-Space Interface Control Document (ICD) for SPS version 1.0 was released in the official ISRO website <http://irnss.isro.gov.in> in October 2014. The information for a user to acquire, track and utilise the SPS navigation signals are provided in the ICD.

With the operationalisation of five spacecraft, proof-of-concept of an independent regional navigation satellite system over India has been demonstrated for the targeted position accuracy of better than 20 mtrs over 24 hours of the day. With the launch and operationalisation of IRNSS-1F, the sixth in the constellation, better position accuracy will be provided.

IRNSS ground segment is responsible for navigation parameter generation and transmission, satellite control, ranging and integrity monitoring as well as time keeping.



ISRO Navigation Centre at (INC) at Byalalu, the Nerve Centre of the IRNSS ground segment

Currently, IRNSS ground segment is operational on 24/7 basis with 13 Indian Range and Integrity Monitoring Stations (IRIMS), one IRNSS Network Timing Centre (IRNWT), one ISRO Navigation Centre (INC) and one Spacecraft Control Facility (SCF) with its data communication network. Along with the deployment of seven satellite constellation, the entire ground segment with two more IRIMS and one each of IRNWT, INC and SCF is planned to be established.

## Applications of IRNSS:

- Terrestrial, Aerial and Marine Navigation
- Vehicle tracking and fleet management
- Terrestrial navigation aid for hikers and travelers
- Disaster Management
- Integration with mobile phones
- Mapping and Geodetic data capture
- Visual and voice navigation for drivers



## Indian Space Research Organisation

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