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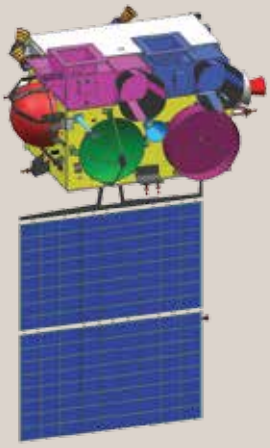
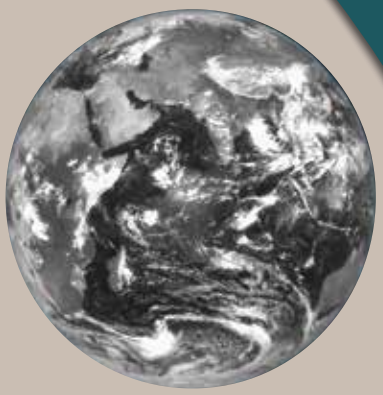


INSAT - 3DR



GSLV-F05/INSAT-3DR

THE VEHICLE

GSLV-F05 is the tenth flight of India's Geosynchronous Satellite Launch Vehicle (GSLV). In this flight, GSLV will launch 2211 kg INSAT-3DR, an advanced weather satellite into a Geostationary Transfer Orbit (GTO). After reaching GTO, INSAT-3DR will use its own propulsion system to reach its final geosynchronous orbital home and will be stationed at 74 deg East longitude. INSAT-3DR will provide a variety of meteorological services to the country. GSLV is designed to inject 2 - 2.5 ton class of satellites into GTO.

GSLV-F05 is the flight in which the indigenously developed Cryogenic Upper Stage (CUS) is being carried on-board for the fourth time during a GSLV flight. GSLV-F05 flight is significant since it is the first operational flight of GSLV carrying CUS. GSLV-F05 will be launched from the Second Launch Pad at Satish Dhawan Space Centre SHAR (SDSC SHAR), Sriharikota.

GSLV-F05 vehicle is configured with all its three stages including the CUS similar to the ones successfully flown during the previous GSLV-D5 and D6 missions in January 2014 and August 2015. GSLV-D5 and D6 successfully placed GSAT-14 and GSAT-6 satellites carried on-board in the intended GTOs very accurately.

Targeted GTO of GSLV-F05	
Perigee	170 ± 5 km
Apogee	35,975 ± 675 km
Inclination	20.61 ± deg

The metallic payload fairing of GSLV-F05 has a diameter of 3.4 m. The overall length of GSLV-F05 is 49.1 m with a lift-off mass of 415.2 tons.

THE VEHICLE

The Cryogenic Upper Stage (CUS) being flown in GSLV-F05 is designed as CUS-07. A cryogenic rocket stage is more efficient and provides more thrust for every kilogram of propellant it burns compared to solid and earth-storable liquid propellant rocket stages.

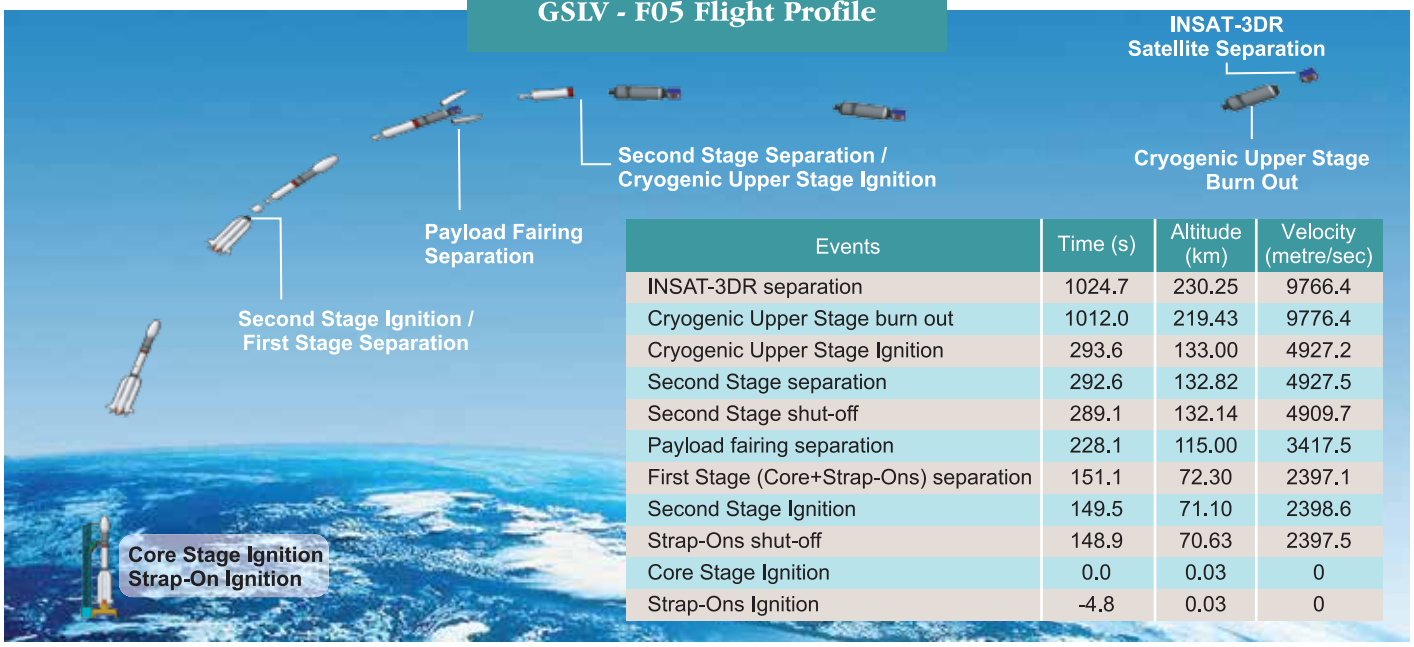
But, a cryogenic stage is technically a very complex system compared to solid or earth-storable liquid propellant stages due to its use of propellants at extremely low temperatures and the associated thermal and structural challenges. Oxygen liquefies at -183 deg C and Hydrogen at -253 deg C. The propellants, at these low temperatures, are to be pumped using turbo pumps running at around 40,000 rpm.

The main engine and two smaller steering engines of CUS together develop a nominal thrust of 73.55 kN in vacuum. During the flight, CUS fires for a nominal duration of 720 seconds.

S-band telemetry and C-band transponders enable GSLV-F05 performance monitoring, tracking, range safety/flight safety and Preliminary Orbit Determination (POD).

Two L40 strap-ons attached to the GSLV-F05 first stage core during launch vehicle integration

GSLV - F05 Flight Profile



Events	Time (s)	Altitude (km)	Velocity (metre/sec)
INSAT-3DR separation	1024.7	230.25	9766.4
Cryogenic Upper Stage burn out	1012.0	219.43	9776.4
Cryogenic Upper Stage Ignition	293.6	133.00	4927.2
Second Stage separation	292.6	132.82	4927.5
Second Stage shut-off	289.1	132.14	4909.7
Payload fairing separation	228.1	115.00	3417.5
First Stage (Core+Strap-Ons) separation	151.1	72.30	2397.1
Second Stage Ignition	149.5	71.10	2398.6
Strap-Ons shut-off	148.9	70.63	2397.5
Core Stage Ignition	0.0	0.03	0
Strap-Ons Ignition	-4.8	0.03	0

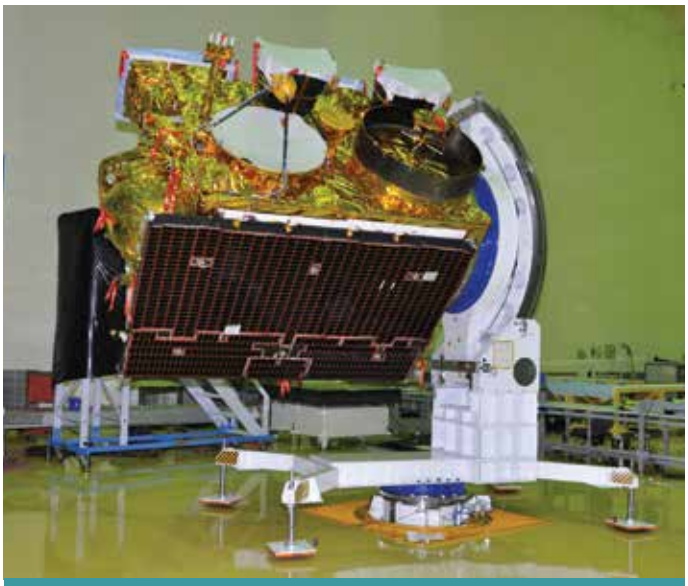
GSLV-F05 at a Glance

Parameters Stage	Stages			
	FIRST STAGE		SECOND STAGE	THIRD STAGE
	Strap-Ons (4 L40 H)	Core Stage (S139)		
Length (m)	19.68	20.18	11.57	8.72
Diameter (m)	2.1	2.8	2.8	2.8
Propellants	UH25 & N_2O_4	HTPB	UH25 & N_2O_4	LH_2 & LOX
Propellant mass (T)	4 x 42.67	138.21	39.44	12.83

HTPB: Hydroxyl Terminated Poly Butadiene, LH_2: Liquid Hydrogen, LOX: Liquid Oxygen
N_2O_4: Nitrogen Tetroxide, UH25: Unsymmetrical Dimethyl Hydrazine + 25% Hydrazine Hydrate

THE SATELLITE

INSAT-3DR is an advanced meteorological satellite of India configured with an imaging System and an Atmospheric Sounder.



INSAT-3DR in the clean room

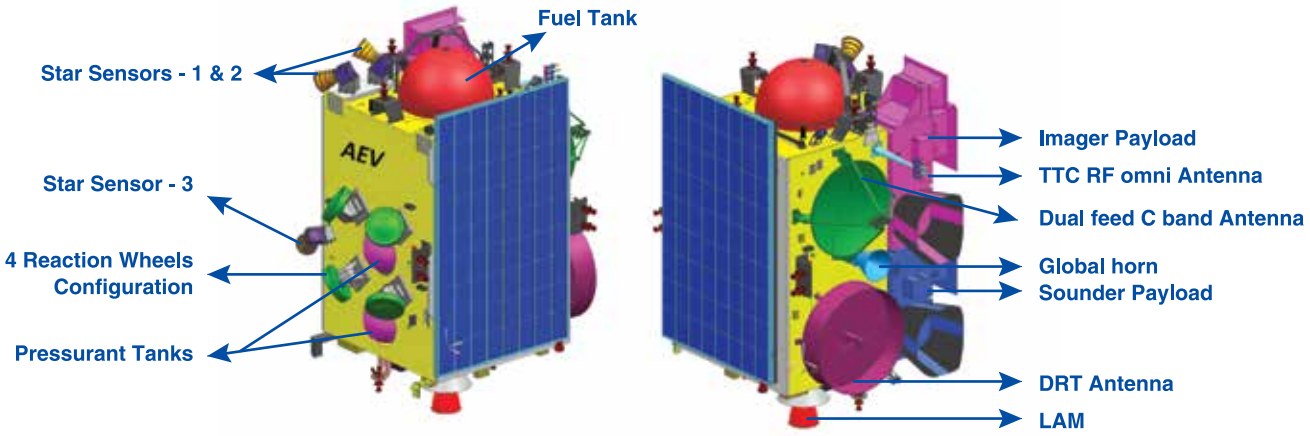
Three meteorological satellites of India – KALPANA-1, INSAT-3A and INSAT-3D – are operational in the geostationary orbit for the past one decade at 74, 93.5 and 82 degree East longitudes respectively. KALPANA-1 and INSAT-3A have imaging systems providing images in the Visible, Near-Infrared, Shortwave Infrared, Water Vapour and Thermal Infrared bands.

INSAT-3D, launched in 2013, added a new dimension to weather monitoring through its Atmospheric Sounding System, which provides vertical profiles of temperature (40 levels from surface to ~ 70 km), humidity (21 levels from surface to ~ 15 km) and integrated ozone from surface to top of the atmosphere. INSAT-3DR, the latest meteorological satellite built by ISRO, is similar to INSAT-3D.

The significant improvements incorporated in INSAT-3D compared to the earlier meteorological missions are part of INSAT-3DR also. These are:

- Imaging in Middle Infrared band to provide night time pictures of low clouds and fog
- Imaging in two Thermal Infrared bands for estimation of Sea Surface Temperature (SST) with better accuracy
- Higher Spatial Resolution in the Visible and Thermal Infrared bands

And, like its predecessor INSAT-3D, INSAT-3DR carries a Data Relay Transponder as well as a Search and Rescue Transponder. Thus, INSAT-3DR will provide service continuity to earlier meteorological missions of ISRO and further augment the capability to provide various meteorological as well as search and rescue services.

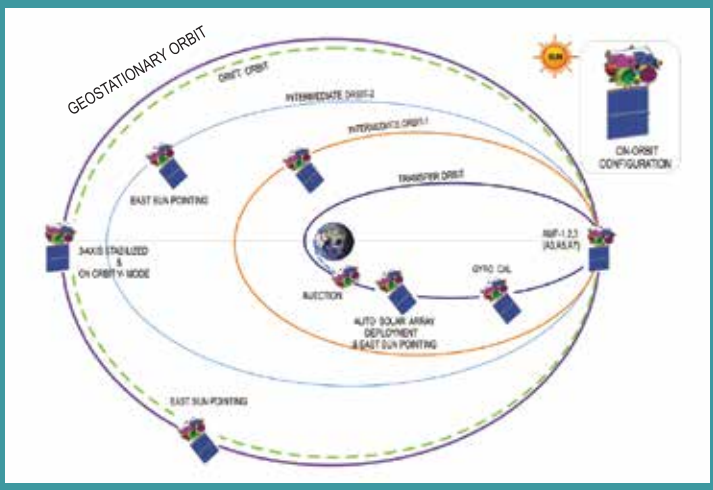


INSAT-3DR configuration details

INSAT-3DR has a lift-off mass of 2211 kg, which includes about 1255 kg of propellant. The propellant carried by INSAT-3DR is mainly required to raise the satellite from the Geosynchronous Transfer Orbit (GTO) to its final Geostationary Orbit and to maintain the satellite in its orbital slot during its life. INSAT-3DR is based on ISRO's two Tonne Class platform (I-2K bus) employing light-weight structural elements like Carbon Fibre Reinforced Plastic (CFRP). The satellite has a solar array generating 1700 Watts of power.

THE SATELLITE

Salient Features	
MISSION	Meteorological and Search & Rescue Services
ORBIT	Geostationary
LOCATION	74 deg E Longitude
MASS AT LIFT-OFF	2211 kg
DIMENSIONS	2.4m x 1.6m x 1.5m
POWER	Two Solar panels generating 1700 W One 90 Ah Li-Ion battery
PROPULSION	440 Newton Liquid Apogee Motor (LAM) and twelve 22 Newton thrusters with Mono Methyl Hydrazine (MMH) as fuel and Mixed Oxides of Nitrogen (MON-3) as oxidiser
STABILISATION	3-axis body stabilised in orbit using Sun Sensors, Star Sensors, Gyroscopes, Reaction Wheels, Magnetic Torquers and Thrusters
ANTENNAE	0.9 m and 1.0 m body mounted antennae
PAYLOADS	Imager, Sounder, Data Relay Transponder and Search & Rescue Transponder
MISSION LIFE	10 years



INSAT-3DR Mission Profile

After reaching GTO onboard GSLV-F05, the solar panels of the satellite will be deployed immediately. Following this, ISRO's Master Control Facility (MCF) at Hassan takes control of the satellite and performs the initial orbit raising maneuvers using the Liquid Apogee Motor (LAM) of the satellite, finally placing it in the circular Geostationary Orbit. Later, INSAT-3DR will be put into its final orbital configuration and positioned at 74 deg East longitude. The designed in-orbit mission life of INSAT-3DR is 10 years.

PAYLOADS of INQAT-3DP

Imager: For meteorological observations, INSAT-3DR carries a multi-spectral Imager (optical radiometer) capable of generating the images of the earth in six wavelength bands significant for meteorological observations, namely, visible, shortwave infrared, middle infrared, water vapor and two bands in thermal infrared regions. The Imager will generate images of the Earth disk from geostationary altitude of 36,000 km every 26 minutes and provide information on various parameters, namely, outgoing long-wave radiation, quantitative precipitation estimation, sea surface temperature, snow cover, cloud motion winds, etc. The Imager payload is an improved version of VHRR flown on INSAT-3A and Kalpana-1 satellites with significant improvements in spatial resolution, number of spectral channels and functionality and was flown in the earlier INSAT-3D.

Sounder: INSAT-3DR also carries 19 channel sounder, which was earlier flown in INSAT-3D. The Sounder has eighteen narrow spectral channels in shortwave infrared, middle infrared and long wave infrared regions and one channel in the visible region. It will provide information on the vertical profiles of temperature, humidity and integrated ozone. These profiles will be available for a selected region over Indian landmass every one hour and for the entire Indian Ocean Region every six hours.

Data Relay Transponder (DRT)

Data Relay Transponder (DRT) on-board INSAT-3DR will be used for receiving meteorological, hydrological and oceanographic data from remote uninhabited locations over the coverage area from Data Collection Platforms (DCPs) like Automatic Weather Stations (AWS), Automatic Rain Gauges (ARG) and Agro Met Stations (AMS). The data is relayed back for downlinking in extended C-Band. For extreme weather related disasters such as cyclone, floods and drought, real time observations of the associated parameters with appropriate network density is very important. Satellite enabled Data Collection Platforms provide a unique solution for gathering meteorological data from all over the country including remote and inaccessible places. India Meteorological Department (IMD) and ISRO have established more than 3000 Data Collection Platforms. INSAT-3DR provides continuity of service of DRT which is currently carried by INSAT-3A and INSAT-3D.

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Satellite Aided Search and Rescue (SAS & R) Transponder

INSAT-3DR is equipped with a Search and Rescue payload (operating in 406.05 MHz) that picks up and relays the alert signals originating from the distress beacons of maritime, aviation and land based users to the Indian Mission Control Centre (INMCC) located at ISRO Telemetry, Tracking and Command Network (ISTRAC), Bangalore.

The major users of Satellite Aided Search and Rescue service in India are the Indian Coast Guard, Airports Authority of India (AAI), Directorate General of Shipping, Defence Services and fishermen. The Indian service region includes a large part of the Indian Ocean region covering India, Bangladesh, Bhutan, Maldives, Nepal, Seychelles, Sri Lanka and Tanzania for rendering distress alert services.

INSAT-3DR will join INSAT-3A and INSAT-3D to provide operational Search and Rescue service.

INSAT METEOROLOGICAL DATA PROCESSING SYSTEM (IMDPS)

Indian Space Research Organisation (ISRO) has taken up the responsibility of end-to-end reception and processing of INSAT-3DR data and derivation of meteorological parameters with India Meteorological Department (IMD), New Delhi. An indigenously designed and developed INSAT Meteorological Data Processing System (IMDPS) is installed and commissioned at IMD, New Delhi with a Mirror Site at Space Applications Centre, Ahmedabad.

IMDPS will cater to the processing of all data transmitted by the Imager and Sounder payloads.

The data archival and dissemination is through IMD, New Delhi and Meteorological and Oceanographic Satellite Data Archival Centre (MOSDAC) websites. IMDPS comprises three major sub-systems - (i) Data Acquisition and Quick Look Display System (ii) Data Products System and (iii) Geo-Physical Parameter Retrieval System.

These Geophysical parameters and products will be derived and ingested into the operational weather forecasting activities at IMD. In addition, some of these parameters, particularly the Atmospheric Motion Vectors (AMVs) from the imager, as well as the temperature and humidity profiles from the Sounder will be ingested in numerical weather forecast models in real time for accurate weather prediction.

PAYLOAD	Geo-Physical Parameters and Derived Products
IMAGER	Outgoing Long wave Radiation (OLR)
	Quantitative Precipitation Estimate (QPE)
	Atmospheric Motion Vector (AMV)
	Upper Troposphere Humidity (UTH)
	Sea Surface Temperature (SST)
	Land Surface Temperature (LST)
	Water Vapor Wind Vector
	Insolation
	Snow Cover
	Fog, Forest Fire, Smoke and Aerosol Identification
	Tropical Cyclone Position and Intensity Estimation
SOUNDER	Temperature, Humidity profiles and Integrated Ozone
	Geo-potential Height (GH)
	Layer Precipitable Water
	Total Precipitable Water
	Lifted Index (LI)
	Wind Index (WI)
	Dry Microburst Index (DMI)
	Potential Temperature Differential
	Ozone estimate

इसरो ISRO Indian Space Research Organisation

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