# → SOYUZ - TMA

# Russian manned spacecraft

Soyuz-TMA is a Russian manned spaceship capable to transport up to three cosmonauts and limited cargo to and from the International Space Station.



# The Soyuz-TMA Spacecraft

The Soyuz is composed by three major modules:

- the Orbital Module (OM),
- the Descent Module (DM), and
- the Service Module (SM).

## THE ORBITAL MODULE (OM)

The OM is a spherical pressurized vessel used by the crew during the orbital phase of the mission. In its front side, it has installed the docking mechanism, the hatch and the rendez-vous antennas, while in the back is the hatch that separates it from the DM.

During the descent phase, the OM separates from the DM during the de-orbit manoeuvre and it disintegrates during the re-entry into the atmosphere.

It can also be used for limited cargo transportation to the ISS and as a disposal vector once undocked from that.

#### Soyuz OM Internal Layout





## THE DESCENT MODULE (DM)

The DM contains all the required means for the safe re-entry of up to three cosmonauts: an independent GNC system, seats, controls and displays, life support provisions, batteries, parachutes, and landing rockets.

Together with the crew, the DM can also transport a very limited mass of payload (150 kg as order of magnitude).

## THE SERVICE MODULE (SM)

The SM is composed by three main sections.

The Transition Section provides the structural interface to the DM and hosts the oxygen storage tanks and the attitude control thrusters

The Instrument Section contains the avionics, the communications, and the control equipment.

The Service Section which represents the structural interface to the launch vehicle and embodies the propulsion system, the batteries, the solar arrays, and the radiator.

As for the OM, the SM separates from the DM during the de-orbit manoeuvre and it disintegrates during its entry into the atmosphere.



Soyuz DM Ir

View on Plane I.

- 1 CA/6O Hatch Lid;
- 2 -CA/6O Hatch Lock Mechanism;
- 3 -**ПK14 Flight Garment;**
- 4 -T3K (Thermal Protective Suit);
- Container: 5 -6 -
- "Kazbek-U" Item (Right);
- 7 -РУО (Rotation Hand Controller);
- 8 -"Kazbek-U" Item (Middle);
- 9 -Luminary;
- 10 -ПЗВС (Spacesuit Fan Circuit Breaker Panel);
- "Forel" Hydrosuit; 11 -
- "Neva-KV" Set; 12 -
- "Kazbek-U" Item (Left); 13 -



### Soyuz DM Interio

View on Plane III.

- PIIB-2 Manual Turn Valve: 26 -
- 27 -PAΠ-10 Manual Antenna Switch: PIR-1 Manual Turn Valve;
- 28 -
- 29 -РУС (Descent Control Handle);
- 30 -ДСД (Pressure Caution/Warning Signal Sensor); 31 -
- PAIT-7 Manual Antenna Switch;
- 32 -1B Manual Cock;
- ПБК Valve Inhibit Switch; 33 -34 -ПБК-Д Command Inhibit Switch:
- 35 -ЭПК-ПСА Electro-pneumatic Valve;
- КРУО (Rotational Hand Controller Commutator); 36 -
- 37 -
- 1HP Manual Pump; 38 -
- ЭПК-РД Electro-pneumatic Valve; 39 -КРУД (Translational Hand Controller Commutator);



## terior Layout

View on Plane II.

14 -РУД (Translation Hand Controller);

- 15 -TV Camera;
- "3B" Manual Cock; 16 -
- 17 -ΠCA-1-φ732 ΠK CA (Descent Module Cosmonaut Panel);
- Flight Data File Container ; 18 -
- BCK-4 Sight; 19 -
- 20 -XCA (Cooling/Drying Unit);
- 21 газоанализатор (ГА) (Gas Analyser);
- 22 -РУО (Rotation Hand Controller) Connector;
- 23 -Pull-Overs:
- 24 -Starboard Window:
- 25 -Push-To-Talk Button;



#### r Layout (Continuation)

View on Plane IV.

- 40 -Regenerator :
- ДМП (Soft Landing Thrusters); ЭПК-П Electro-pneumatic Valve; 41 -42 -
- 43 -Port Side Window ;
- 44 -"Kazbek-U" ItemShock Absorber;
- 45 -
- **BP-1** Distribution Unit;
- 46 -Payload Container; 47 -
- BK Separation Contact Command (KO)Issue Unit; CJB (Ventilation Valve System) Shutter Control; EPYC (CA Manual Control) Unit; 48 -
- 49 -
- 50 -"Gnom-M" Tape Recorder;
- 51 -БПК Plug Cap;
- 52 -K1 Telegraph Key;
- Pressure Sealed Lead Through Plate; 53 -
- "4B" Manual Cock 54 -

# Specifications

## SOYUZ-TMA SPECIFICATIONS AND PERFORMANCES

Design Life:	14 days
Orbital Storage:	200 days
Typical Orbit:	407 km circular, 51.6° incl.
Length:	6.98 m
Diameter of habitable modules:	2.20 m
Maximum Diameter:	2.72 m
Span:	10.60 m
Habitable Volume:	9.00 m³
Launch Mass:	6,800 kg
Main Engine Thrust:	400 kgf
Main Engine Propellants Type:	$N_2O_4$ / UDMH
Main Engine Propellants Mass:	900 kg
Main Engine Isp:	305 s
Spacecraft delta-v:	390 m/s
Electrical System:	Solar Panels
	Span: 10.60 m

Area: 10.00 m<sup>2</sup>

2.26 m

2.15 m

2,600 kg

Power: 0.60 kW average

50 kg (for crew of 3)

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150 kg (for crew of 2)

### **SERVICE MODULE (SM)**

Length: **Basic Diameter:** Mass:

## **DESCENT MODULE (DM)**

Length:	2.24 m
Basic Diameter:	2.17 m
Maximum Diameter:	2.17 m
Habitable Volume:	3.50 m <sup>3</sup>
Mass:	2,900 kg
Crew Mass:	2,55 kg
Upload Payload Mass:	100 kg (for crew of 3)
	200 kg (for crew of 2)

**Download Payload Mass:** 

#### **ORBITAL MODULE (OM)**

Length:	2.98 m
Basic Diameter:	2.26 m
Maximum Diameter:	2.26 m
Habitable Volume:	5.00 m3
Mass:	1,300 kg

## PROJECT: International eesa

TITLE:

**Space Station** 

DOCUMENT N°: REV. Soyuz TMA Vehicle ESA-HSO-COU-035 2.0

# Utilisation Relevant Data

## LAUNCH CONFIGURATION

Launch vehicle: Launch site: First flight of Soyuz-TMA: Flight rate: Soyuz rocket Baikonur, Kazakhstan 30 October 2002 Mean: 4-8/year

## **ON ORBIT CONFIGURATION**

Deployed solar arrays, with a total span of 10.6 m, that provide electrical power.

## **MISSION PHASES**

- Spacecraft (and cargo) integration,
- Launch,
- Transfer flight to the ISS,
- Docking to the ISS,
- Docked operations,
- Cargo transfer to the ISS,
- Undocking from the ISS,
- Free flight after undocking,
- De-orbiting,
- Re-entry and landing,
- Recovery,
- Early retrieval,
- De-integration at ground facilities.



- 1. Lift-off contact ( $K\Pi$ ) (h=0 km; t=0 s).
- 2. Jettison the launch escape system propulsion system (h=46 km; t=115 s).
- 3. Separation of LV 1st stage (h=49 km; t=118 s).
- 4. Jettison the nose fairing (h=84 km; t=165 s).
- 5. Separation of LV 2nd stage (h=167 km; t=288 s).
- 6. LV 3rd stage shut-off command, microgravity (h=202 km; t=526 s). 3rd stage separation contact (KO) (t=530 s).
- 7. Autonomous orbital flight (prior to docking with the orbital complex) up to 1.9 days.
- 8. Mated orbital flight (as part of the orbital complex) up to 210 days.
- 9. Undocking from the orbital complex, autonomous pre-descent flight, up to 1.3 days.
- 10. Vehicle compartment separation.
- 11. Jettison primary parachute (OCΠ) cover.
- 12. Deploy the pilot parachute and the drogue parachute, in turn, to reduce the rate of descent.
- 13. Deploy the main canopy and jettison the drogue parachute.
- 14. Jettison the heat shield, jettison external window panes, open the automatic pressure control unit (БАРД) (h=5.5 km)
- 15. Re-hook the main canopy for symmetrical suspension, HF (KB) beacon, pressurize the OCΠ container ullage, release air from the ullage cylinder of the backup parachute (**3**CΠ) in the CA (Descent Module).
- 16. Firing of soft-landing engines, opening of the ambient air ventilation system (C**μ**B) valves, landing, damping the landing velocity by deformation of the bottom and the shock-absorbing seats.