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Conceptual Design of KOMPSAT-2 Mechanical System

Gyu-Sun Kim*

Abstract

In December of 1997, Korea Aerospace Research Institute begin to develop the conceptual design of Kompsat2 as the Kompsat1 design is nearly completed. Basic direction of this design was set up to utilized the heritage of Kompsat1 and modify the payload module to accommodate the new high resolution space borne camera. And in the early stage of this design, total system configuration design study was conducted based on 1st level payload information.

In this paper, mechanical system design at various stage is documented and this will be used as a path finder or guidelines in the future feasibility study or conceptual design.

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 : 2 (KOMPSAT-2), (mechanical system), (conceptual design), (system design), (spacecraft bus)

1. 2 가
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* / gskim@kari.re.kr

AOCS	Attitude and Orbit Control Subsystem	MGSE	Mechanical Ground Support Equipment
APM	Antenna Pointing Mechanism	MSC	Multi-Spectral Camera
ASP	Analog Sinal Processor	NTE	Not To Exceed
B.C	Bolted Circle	PCE	Power Conditioning Electronics
CES	Conical Earth Sensor	PDR	Preliminary Design Review
CEU	Camera Electronics Unit	PDTS	Payload Data Transmission System
C&DH	Command & Data Handling	PMU	Payload Management Unit
C&H	Cable & Harness	PS	Propulsion Subsystem
DSP	Digital Signal Processor	RF	Radio-Frequency
DTM	Dual Thruster Module	PSU	Power Supply Unit
EPS	Electrical Power Subsystem	RFP	Request For Proposal
F/D	Fill & Drain	RWA	Reaction Wheel Assembly
FOV	Field Of View	S/ C	Spacecraft
FPE	Focal Plane Electronics	SDR	System Design Review
GRA	Gyro-Reference Assembly	SMS	Structure and Mechanism Subsystem
HRM	Hold & Release Mechanism	TBD	To Be Determined
ICD	Interface Control Document	TC&R	Telemetry Command & Ranging
IPT	Integrated Product Team	TM	Technical Memorandum
I&T	Integration & Test	XBA	X-Band Antenna
KOMPSAT	KOrea Multi-Purpose Satellite	XBU	X-Band Unit
L/ V	Launch Vehicle		

가 . '99 2
 2 MSC
 (Multi-Spectral Camera)
 가 2 DASA ELOP 가
 가
 가 2.6m
 . '98 9 2 800 Kg
 2
 가 '99
 . '98 12 가
 2 ELOP Telescope

가
가 DTM(Dual Thruster Module)

MSC Telescope Electronic box

PDTS: Extended FMU + Transmitter(2ea) + RF assembly + Antenna

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■ **Top level mass breakdown**

Spacecraft: Kompsat1(728 LBS)*454=330.5 kg → 450 Kg Allocation

Propellant: 72.6 Kg(Kompsat1)

Payload: 200Kg(MSC + 2nd Payload + PDTS + Payload Adapter)

System margin: 10% -->77.4 Kg

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■ **MSC/Telescope Envelope**

LMLV2 Fairing/ Dynamic envelope : 148.7inch

Kompsat2 : 79.2 inch”(TBR)

: 14

inch”(TBR)

Telescope : 70" → Margin

1.5m(60”)

Telescope Diameter: 0.75m LMLV2

Fairing 가

가
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■ **MSC/Electronics**

Max. allowable height: 13”(33cm)

(W*L*H): 30cm*50cm*33cm

EOC 가

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PDTS 가 :

> KOMPSAT1 X-Band RF System + FMU (30cm*38cm*33cm)

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2.1

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KOMPSAT1

Modular : , , ,

1 : Longeron, Rail , Platform, S/ C Adapter

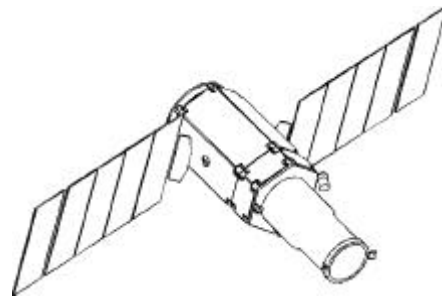
Layout:-Kompsat1

(19.73" by 53" → 26" by 60")

47" B.C(Bolted Circle)

- 가
: LMLV2,Taurus →
800kg @685 Km Sun-Sync Orbit
Kompsat1 Mechanical Architecture
1 Kw Solar Array(: 10m2)

2.1 Budget
 , 2.1~ 2.4
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2.2. Kompsat2 Flight Configuration

2.1. Mass Budget-SaTREC Presentation

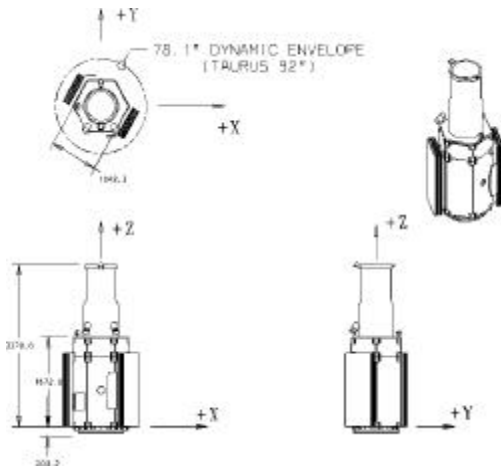
구분	질량(kg)	ICMS#	비고
Hybrid ME Telescope Electronics HDS 2xHybrid H-Aperture MLoad Hardware	30	15281BH7807(kg)	HybridMe- MCTelescope +ME Electronics +HDS +Hybrid/Aperture (ETelescope) +2xHybrid +Intrastructure/Intra +ML+Inf Hardware
Structural Structure Turret ACS Propulsion HS TCAR	400 100 150 50 250 140 300	76211BH3698(kg) 277311BH0299(kg) 21891BH0584(kg) 95391BH0208(kg) 29761BH0925(kg) 28581BH0289(kg) 4891BH0223(kg)	Support()
Hydriant	726	1011BH7206(kg)	
Stellite(Dy)	690	927151BH4098(kg)	Hybrid/Structural
Magnet	774	3521BH15088(kg)	
Stellite(ME)	726	108151BH4902(kg)	Hybrid/Structural/Hydriant
LVCapability	80	1123321BH910(kg)	IMV2, Tera

2.2 KODAK Camera

1998 5 Lockheed Martin
 Im IKONOS
 Kodak 2

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- Kodak Multi-Spectral Camera(Information based on presentation 5/ 2/ 98)
- Telescope Envelope: Assumed dimension Diameter 0.8m, Length 1.5 m
- Electronics:
 - > FPE&ASP(Focal Plane Electronics and Analog Signal Processor):
 - . Dimension 10" x 9" x 10"
 - . Mass: 42 LBS
 - > DSP(Digital Signal Processor):
 - . Dimension 18" x 12" x 7.5"
 - . Mass: 39 LBS
 - > PCE(Power Conditioning Electronics):
 - . No information → Assumed 80% of DSP
 - > PDTS(Payload Data Transmission System)
 - . Data Processing Unit + Solid State Recorder:
 - . Assumed Two Unit with Dimension of 11" x 7.5" x 7.5"



2.1. Kompsat2 Stowed Configuration

- ” . Assumed Mass for Two Unit 20 LBS each
- > RF System: KOMPSAT1 Unit 가
- . X-Band Transmitter 2ea, X-Band RF Switch 1ea, X-Band Omni Antenna.
- System Configuration Requirement
 - > Embedded Telescope to Spacecraft main Body
- Solar Array Sizing
 - > Power Requirement: 1,130 W EOL
 - > Solar Array: 26" by 70", 10 ea
- Candidate Launch Vehicle
 - > Taurus 92", LMLV2 92, 38" inch launch vehicle interface

- > Boxes are mounted on Six Bulk-Head
 - > Body Panel Mounted Battery
 - AOCS Sensors(Star Tracker, CES)
 - > Mounted on Nadir Platform+Z
 - Aux. Payload(?) will be mounted on Nadir Platform+Z
- 2.3 1 Cone/ 가
- Cylinder 1 Kodak Camera Cone/ Cylinder

■ Basic Architecture and Mechanical System Design Description

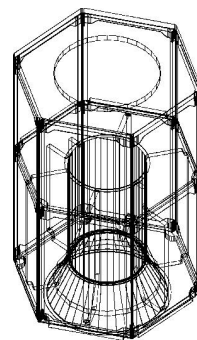
- Hexagonal Shape with Longeron, Rails and Platform
- Cone/ Cylinder for Primary Load Carrying Structure
- Three Platforms(Nadir, Central, Zenith)
- Nadir Equipment Module for Payload Electronics.
- Six Bulk Head in Avionics Module for Spacecraft
- Equipment Mounting and Load transfer from Payload to Cylinder/ Cone
- Cylinder/ Cone for 72 kg Capacity Propellant Tank mounting.
- Zenith Platform for Propulsion Components accommodation
- DTM will be mounted on inside of Cone

■ Basic Architecture and Mechanical System Design Description

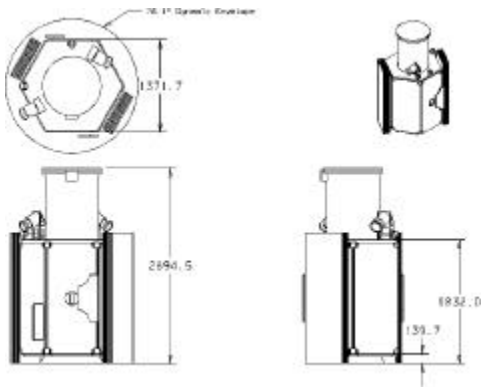
- Nadir Equipment Module for Payload Components
 - > PDTs Boxes on Nadir Platform-Z
 - > DSP & PCE on Inside of Body Panel
- Avionics Module for Spacecraft Components

2.2. Mass Budget - KOMPSAT2 with KODAK CAMERA

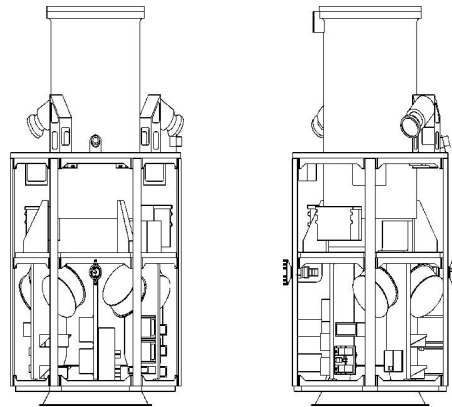
구분	질량(Kg)	KOMPSAT1	비고
Payload Telescope Electronics Aux. Payload HDS Data Processing/Storage RF System	200	162.93 LBS(73.97 Kg)	
Spacecraft Structure(?) Thermal AOCS(?) Propulsion EES+GHR(?) CDSM	570.0 180.0 14.0 120.0 25.0 100.0 100	784.21 LBS(355.96 Kg) 277.31 LBS(125.94 Kg) 209.18 LBS(95.14 Kg) 91.89 LBS(41.84 Kg) 59.70 LBS(27.02 Kg) 223.94 LBS(101.60 Kg) 419 LBS(190.21 Kg)	Kompsat 2의 구조는 1999년 12월 22일 CDSM Star Tracker, Star Signal ISAN/IS SOLAR CELL Array, 1,130W Solar Array
Propellant	72.6	161 LBS(72.6 Kg)	
Satellite(Dry)	770.0	827.15 LBS(375.98 Kg)	Payload/Spacecraft
Margin	57.4	125.2 LBS(56.84 Kg)	
Satellite(Wet)	822.6	1088.15 LBS(494.02 Kg)	Payload/Spacecraft+Propellant
L/V Capability	900.0	1123.35 LBS(510 Kg)	LMLV2, Taurus



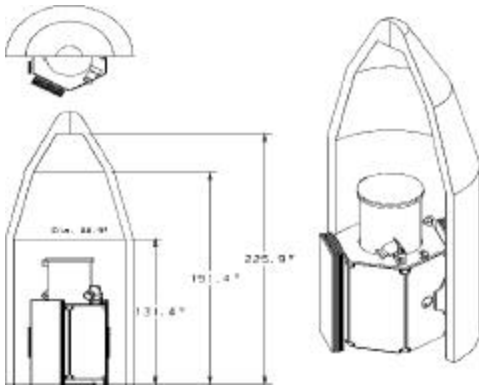
2.3. Mechanical Architecture



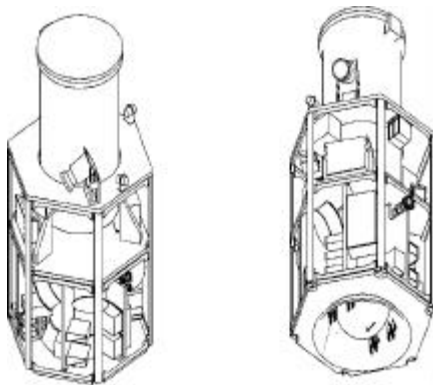
2.4. Stowed Configuration - KOMPSAT2 with Kodak Camera



2.7. Avionics Layout for Kompsat2 with



2.5. KOMPSAT2 with Kodak Camera in Taurus XL Fairing

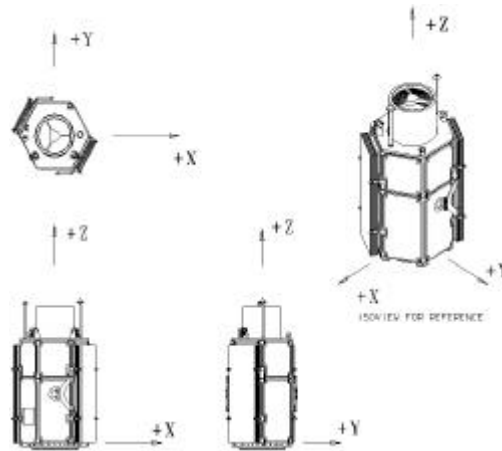


2.6. Avionics Layout for Kompsat2 with Kodak Camera (1)

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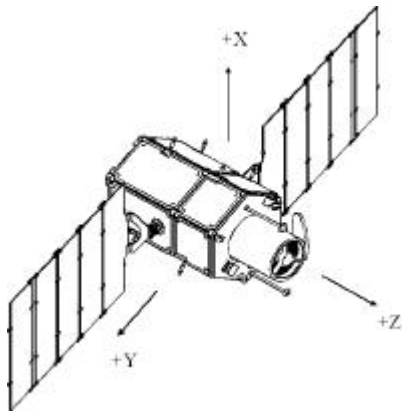
2.8. Kompsat2 System Configuration - Preliminary Design

- System Requirement
- - KOMPSAT1 Heritage

- > Launch Mass: 800 Kg
- > Modular Design
- > MSC Payload Accommodation
- > Launch Vehicle Accommodation
 - . Athena2 92, Taurus 92, ROCKOT, KOSMOS
- > KARI Thermal Vac. Chamber Accommodation

■ **Derived Requirement**

- > Easy Access to Avionics during I&T
- > Optical Access to Align Need Components
- > Modularized Battery mounting

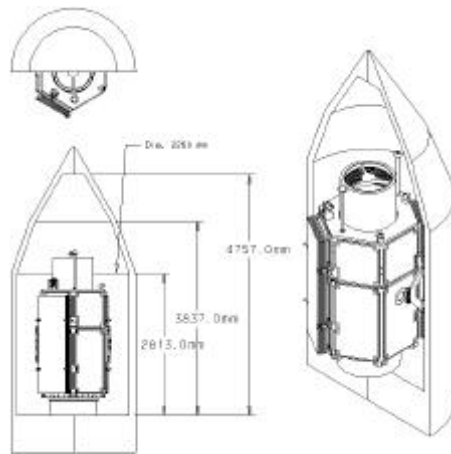


2.9. Kompsat2 Flight Configuration -

2.3. Mass Budget - Preliminary Design

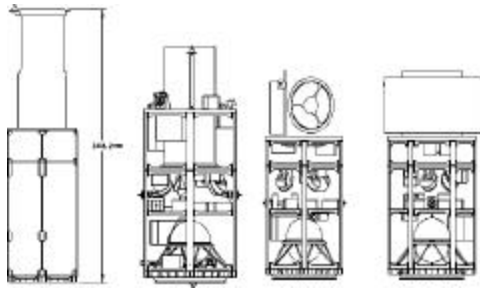
	(kg)	KOMPSAT 1	
Payload Telescope Electronics Aux. Payload PDIS Data Processing/ Storage RF System	200	1629LBS(7397kg)	
Spacecraft Structure Thermal ACCS Propulsion EPS/C&H(?) C&DH	513.0 160.0 13.0 72.0 22.0 220.0 26.0	764.2LBS(3469kg) 277.33LBS(125.9kg) 2099LBS(953kg) 93.39LBS(42.4kg) 39.7LBS(18.0kg) 283.84LBS(128.8kg) 489LBS(222kg)	Kompsat1 Sodem Star Tracker, Ithaco Type BRWA 50Ah NiCd Battery, Silicon Cell 1,130W Solar Array
Propellant	73.0	161LBS(72.6kg)	
Satellite(Dry)	713.0	927.15LBS(421.93kg)	Payload+Spacecraft
Margin	14.0	35.2LBS(15.98kg)	Payload+Spacecraft+Propellant
Satellite(Wet)	800.0	1088.15LBS(494.02kg)	Athena2, Taurus, ROCKOT, KOSMOS
L/V Capability	800.0	1123.35LBS(510kg)	

- - Candidate Launch Vehicle(TBR)
 - > Athena2/ 92-38: Athena2, 92" Fairing, 38" Adapter
 - > Taurus/ 92
 - > ROCKOT
 - > KOSMOS
 - Baseline Design for 38.81" L/V Interface B.C(Bolted Circle)
 - One Fairing Access Door: Location TBD
 - Marmon Clamp Band Separation System Supplied by L/V Contractor
 - Two Separation Connector Location TBD



2.10. Kompsat2 in ROCKOT Launch Vehicle - Preliminary Design

- - - MSC & PDIS Accommodation
 - > Partially Submerged Telescope Mounting
 - > Circular Cut-Out in Payload Platform
 - > Telescope Mounting Details TBD
 - > Body Panel Mounting of Payload Electronics*
 - > Heat Pipe for Payload Electronics(??)
 - > Deployable X-Band Antenna(??)
 - Auxiliary Payload: No Information



2.11. Payload Accommodation Trade off Study

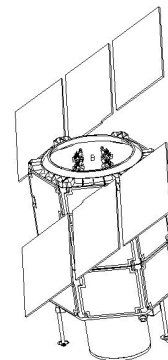
■ **Spacecraft Bus**

- Central Module
- Avionics Module
- Nadir & Central Platform
- Platform
- Battery Module
- Solar Array
- Propulsion Module
- > 1 /
- > Truss

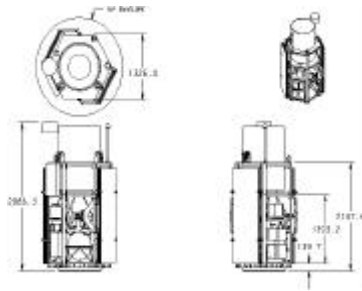
■ [6]

- Trade Off Study
 - KOMPSAT2 가 가
- - > 1 ('98. 10. 27): IPT , AOCS , S/A Electrical Design, Stiffness Analysis of Flat-pack S/A
 - > 2 ('98. 11. 3): Solar Cell Risk Assessment, S/A Damper in EOS/TRW, AOCS Requirement Update.
 - > 3 ('98. 11. 10): S/A MFG, Fixed/ Wrap Around S/A Concept
 - > 4 ('98. 11. 24): Stiffness Analysis of Fixed/ Wrap Around S/A, AOCS Assessment of Fixed/ Wrap Around S/A, Restraint/ Deployment System for

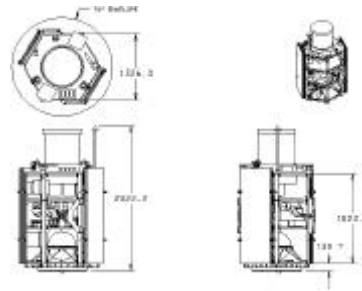
- Fixed/ Wrap Around S/A
- > 5 ('98. 12. 1): Evaluation of Three S/A Design in Subsystem Standpoint
- - Design#1: Flat-Pack, Si-Cell Array:
 - > 25" by 76" substrate, 5 panels per wing, 2 wings in satellite
 - > SADA/ SADE Sun-Tracking
 - > KOMPSAT1 Restraint/ Deployment system
 - > Estimated Mass: 89.9 LBS/ Wing
- Design #2: Flat-Pack, GaAs Cell Array
 - > 27" by 76" substrate, 3 panels per wing, 2 wings in satellite
 - > SADA/ SADE Sun-Tracking
 - > KOMPSAT1 Restraint/ Deployment system
 - > Estimated Mass: 58.3 LBS/ Wing•
- Design #3: Fixed/ Wrap Around, GaAs Cell Solar Array
 - > Fixed Wrap Around Solar Array
 - > 27" by 76" Substrate Size
 - > 0.75" Gap between Panel to panel
 - > 6" Gap(TBR) from body panel to Central Solar panel for Root Hinge Accommodation
 - > 38° Rotation of Solar Array with respect to S/C Y axis
 - > Estimated Mass: 50.2 LBS/ Wing



2.12. Kompsat2 with Wrap Around Solar Array



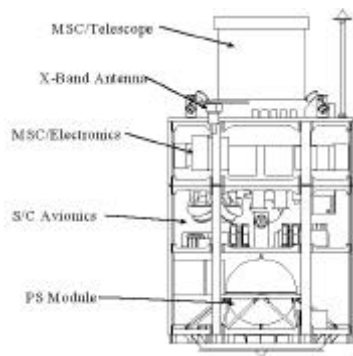
2.14. Kompsat2 Configuration with DASA Payload



2.16. Kompsat2 Configuration with ELOP Payload

■ ELOP

- Telescope Mounted on Payload Platform
 - > Stiffness of Platform with Telescope is big challenge for SMS
- Payload Electronics on Payload Body Panel
 - > APM Accommodation
 - It is not clear that how APM with Antenna works
- Spacecraft Avionics
 - > No change from Baseline Design
 - > GRA, RWA on Nadir -Z
 - > Most S/ C Avionics on Central +Z
- Propulsion Module
 - > No Change from Baseline Design
- Nearly Same MGSE/ I&T Concept as K



2.15. Kompsat2 with ELOP Payload

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ELOP

■ System Requirement

- Utilize the KOMPSAT1 Heritage Design as much as possible.
- Launch Mass: 650 - 700 Kg(TBR)
- Modular Design: Parallel Integration & Test
- MSC Payload Accommodation
- Launch Vehicle Accommodation
- Athena2-92, Taurus 92, ROCKOT, KOSMOS, Delta II/ Dual Launch, LM2C
- KARI Thermal Vac. Chamber Accommodation: Height < 2.65 m

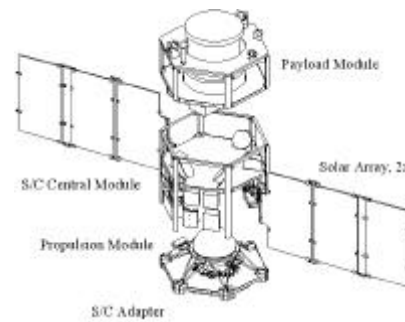
■ Derived Requirement

- Easy Access to Avionics during I&T
- Optical Access to Alignment Need Components(Sensors, RWA, GRA)
- Modularized Battery mounting
- De-fueling Capability at Launch Pad(TBD)

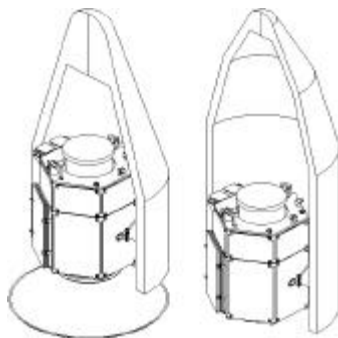
2.5. Mass Budget-Kick Off Meeting

-
- Candidate Launch Vehicles
 - > Athena2/ 92”Fairing
 - > Taurus 92” Fairing
 - > Eurokot/ Rocket
 - > Kosmos
 - > PSLV/ Dual Launch Option
 - > DeltaII/ Dual Launch Option
 - > LM2C/ Dual Launch Option
- Mechanical Interface Requirements(TBR)
 - > Max. Launch Mass: 650 - 700 Kg(TBR)
 - > 38.81 inch(985.8 mm) BSC Interface
 - > Dual Marmon Ring Clamp Band Separation System
 - > Two Separation Connector & Location TBD
 - > One Fairing Access Door for Battery IFJ
 - > One another Door for F/ D Valve & PS Module Connector Bracket Access in case of De-fueling Capability required.

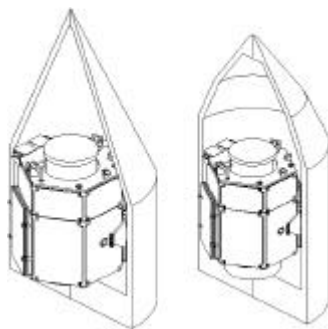
Subsystem	Allocation(Kg)	Remarks
Payload	1200	NTE(Not To Exceed)
Spacecraft	4800	Spacecraft Dry Mass Allocation in SRD
- Structure	1600	
- Thermal Control	15.0	
- Propulsion	23.0	
- AOCS	70.0	
- EPS	190.0	
- TC&R	22.0	
Propellant	73.0	Battery & Solar Array Mass need to refine
Ballast	15.0	
Margin	12.0	
Satellite-Wet	7000	



2.19. Kompsat2 Modular Design Concept



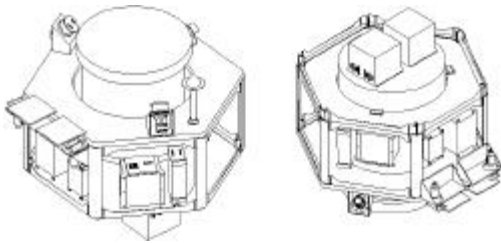
±x 2.17. Kompsat2 with Athena2 & Taurus



2.18. Kompsat2 with Cosmos & Rocket

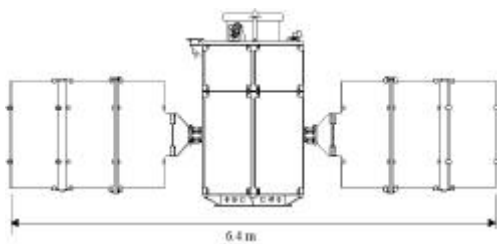
-
- MSC Physical Envelope & Mass in NTE Value
 - > Mass: 120 Kg Total & Mass Value for Each Configurable Item
 - > RF Components Mass/ Envelope will be Fixed @ MSC/ SDR(DPMU & PAMU)
- Unit Drawing(Draft) were issued from ELOP(MSC Contractor)
 - > Most of Interface Items will be specified in ICD
 - • EOS & X-Band Antenna FOV
 - • Mounting Interface
 - • Nominal Interface & Interface Displacement
 - > MSC/ EOS Thermal Conductor
 - • Thermal Conductor in detail will be specified in ICD

- • Most Outstanding Issue in this point
 - > X-band Antenna HRM: Dessuelt 7CCD 15PWH
 - > Thermal Radiator Size for MSC Components
- • EOS/ CEU-MS: 0.06 m²(TBR)
- • EOS/ CEU-PS: 0.06 m²(TBR)
- • Others will be specified in ICD



2.20. Payload Module Configuration - Kick Off Meeting

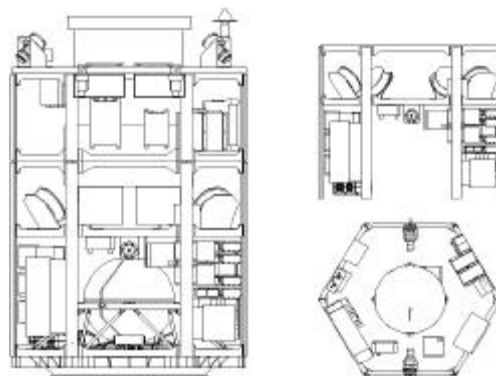
- Solar Array Mechanical Design / Size
- KOMPSAT1 Design Heritage
 - > Flat Pack S/ A Packaging
 - > Tape Hinge Deployment System
 - > Serrated Plate/ Sep Nut Restraint System
 - > Match Drill for S/ A Installation
- S/ A Trade Off Study based on MSC RFP (98/ 12)
 - > 300W Payload Power



2.21. Kompsat2 Deployed Configuration - Kick Off Meeting

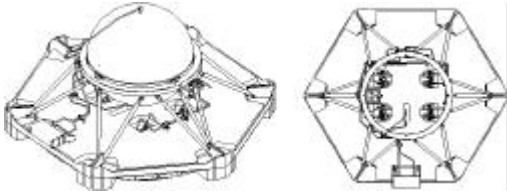
- Central Module
 - > Avionics Module

- > Nadir & Central Platform
- > Battery Module
- > Solar Array
- > Propulsion Module
- • Tank Support Truss Structure
- • PS Modules on PS Platform +Z
 - > Spacecraft Adapter
- Radiator for the Thermal Conductor of MSC/ CEU in Upper -Y Body Panel
- Central Platform for GRA and RWA
- Body Panel Mounted Avionics(TBR)
 - > Body Panel, +X+Y: OBC, RDU*2, S-Band RF Assy
 - > Body Panel, -X+Y: VDE, GPS Rx*2, ECU*2, SADE, DDC
 - > Body Panel, +X-Y: SAR*2, S-Band Xponder*2, PCU
 - > Body Panel, -X-Y: Thermally Isolated Battery Module
 - > Body Panel +Y, & -Y : Avionics Access Panel
- Battery Module
 - > KOMPSAT1 Design Heritage
 - > Modularized Battery Accommodation
 - > Thermally Isolated from Avionics Module
 - > Dedicated Heat Pipe for Battery
 - > Externally Mounted Extended Radiator



2.22. Kompsat2 Mechanical Layout - Kick Off Meeting

- - Propulsion Module Accommodation Design
 - Modular Design: Parallel Design & Integration
 - Truss/ Ring Structure for the Tank Support
 - PS Modules mounted on the PS Platform+Z
 - 1 or 2 I/F Connector Bracket



2.23. Kompsat2 PS Module Layout - Kick Off Meeting

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2. , " - Kompsat2 Mechanical System with Embedded Kodak Multi-Spectral Camera" 1998, 5. 20
3. , " Mechanical System" 1998. 12.
4. , " - Mechanical Interface Study for KSAT2 Spacecraft to MSC", 1999. 3.
5. " - Mechanical Design Integration", 2000. 2.
6. . KARI.TM-MSE-K2-9801 " 2 ", 1998.12. 29

1. , " 2 Mechanical System Conceptual Design, SaTREC ", 1998. 1.6, ,