1. Satellite Overview

1.1 Overview

ADEOS (Advanced Earth Observation Satellite) installed with two core sensors and six AO sensors is one of the earth observation satellites. This satellite performs global observation, maintains and expands earth observation techniques that have been established for MOS-1, MOS-1b and ERS-1 satellites. In addition to this, its role includes further development of future satellite systems like polar orbit type platforms and necessary related technical development for inter-orbital communications to relay observation data.

In this chapter, specification of ADEOS Satellite is stated for the condition to study of data processing algorithm. This specification is referenced to the following documents; "ADEOS to Ground Station Interface Document (version 0) and "ADEOS OPERATION INTERFACE SPECIFICATION DRAFT (Version 1.4)".

1.2 Orbit

Nominal Orbit parameters of ADEOS is as follows:

(1)	Category	:Sun-synchronous sub-recurrent
(2)	Local Time At Decending Node	:10:15 to 10:45 am
(3)	Revolutions Per Day	:14+1/41
(4)	Recurrent Period	:41 days
(5)	Shifting Direction	:eastward
(6)	Altitude	:796.75 km
(7)	Inclination	:98.59 deg.
(8)	Period	:100.92 min.
(9)	Revolutions Per Recurrent	:585
(10)	Minimum Distance Between Orbits (Equator)	:68.5 km
(11)	Accuracy of Recurrent (Equator)	:±5 km

Estimated orbit element error by rocket is as follows;

Semi-major axis error Δa	:±20 km
Eccentricity error Δe	:±0.004
Inclination error Δi	:±0.25 deg.

Orbit fixing accuracy (3) is as follows;

Position accuracy	:1 km	Predicted figure for 3 days later
	150 m	Fixed figure
Velocity accuracy	:1m/sec	Predicted figure for 3 days later
	15 cm/sec	Fixed figure

1.3 Attitude

Attitude accuracy and stability at normal attitude control period are shown as follows;

Attitude accuracy	:roll angle	±0.3 deg.
(3)	pitch angle	±0.3 deg.
	yaw angle	±0.3 deg.
Attitude stability accuracy	:roll angle	±0.003 deg./sec
(3)	pitch angle	±0.003 deg./sec
	yaw angle	±0.003 deg./sec
Attitude fixing accuracy	:roll angle	±0.155 deg.
(3)	pitch angle	±0.155 deg.
	yaw angle	±0.155 deg.

These figures are not applicable at the following times:

(1)Orbit control period

(2)Start and stop time of MDR

(3)Start time of scanning mirror of OCTS

(4)Pointing period of AVNIR

1.4 Definition of Coordinate Systems

(1) Definition of Coordinate Systems

Coordinate Systems used in data processing are defined in Table 1.4-1.

Table 1.4-1 Definitions of Coordinate Systems

No.	Coordinates	Definitions
1	Orbital coordinates	Origin: Center of gravity of satellite X_O: Y_O x Z_O direction Y_O: Opposite direction from orbit plane vector Z_O: Geocentric direction
2	Satellite coordinates	Origin: Center of gravity of satellite XB: Parallel to each axis of satellite fixed coordinates YB: Parallel to each axis of satellite fixed coordinates ZB: Parallel to each axis of satellite fixed coordinates
3	Satellite fixed coordinates	Origin: Intersection of central line of payload attach fitting and separation plane X_S: Axis perpendicular to separation plane Y_S: Z_S x X_S direction Z_S: Earth head axis (positive earth direction)
4	Sensor unit reference coordinates	Origin: Intersection of reference installation hole at central axis and interface plane X_U: Direction of satellite progress Y_U: Z_S x X_S direction Z_U: Normal direction for installation plane (positive earth direction)

(2) Coordinate Transformation

Assume matrices which revolve around coordinate axes are expressed as follows;
Matrix that revolves φ coordinate system around Z-axis is written

$$R_Z(\psi)=\begin{pmatrix} \cos\psi & \sin\psi & 0 \\ -\sin\psi & \cos\psi & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

Matrix that revolves θ coordinate system around Y-axis is written

$$R_Y(\theta)=\begin{pmatrix} \cos\theta & 0 & -\sin\theta \\ 0 & 1 & 0 \\ \sin\theta & 0 & \cos\theta \end{pmatrix}$$

Matrix that revolves ϕ coordinate system around X-axis is written

$$R_X(\phi)=\begin{pmatrix} 1 & 0 & 0 \\ 0 & \cos\phi & \sin\phi \\ 0 & -\sin\phi & \cos\phi \end{pmatrix}$$

a) Transformation between orbit coordinate system and satellite coordinate system

This is transformation on attitude data. Directional Vector X_O for the orbit coordinate system is transformed to directional Vector X_B for satellite coordinate system by the following equation,

$$X_B = R_X\,(RX1)R_Y\,(RY1)R_Z(RZ1)X_o$$

where,
- RX1 : Attitude angle around the X-axis (roll angle)
- RY1 : Attitude angle around the Y-axis (pitch angle)
- RZ1 : Attitude angle around the Z-axis (yaw angle) and acquired by attitude telemetry.

b) Transformation between Satellite coordinate system and Satellite fixed coordinate system

For this transformation coordinate axes coincide and only the origin moves.

c) Transformation between Satellite fixed coordinate system and sensor unit standard coordinate system

This is transformation on sensor alignment. Directional Vector X_O for Satellite fixed coordinate is transformed to Directional Vector X_B for satellite coordinate system by the following equation,

$$Xu = R_X (RX3) R_Y (RY3) R_Z (RZ3) X_S$$

where, RX3 Installed angle of sensor around the X-axis (roll angle)
RY3 Installed angle of sensor around the Y-axis (pitch angle)
RZ3 Installed angle of sensor around the Z-axis (yaw angle)

These are stored in Database.