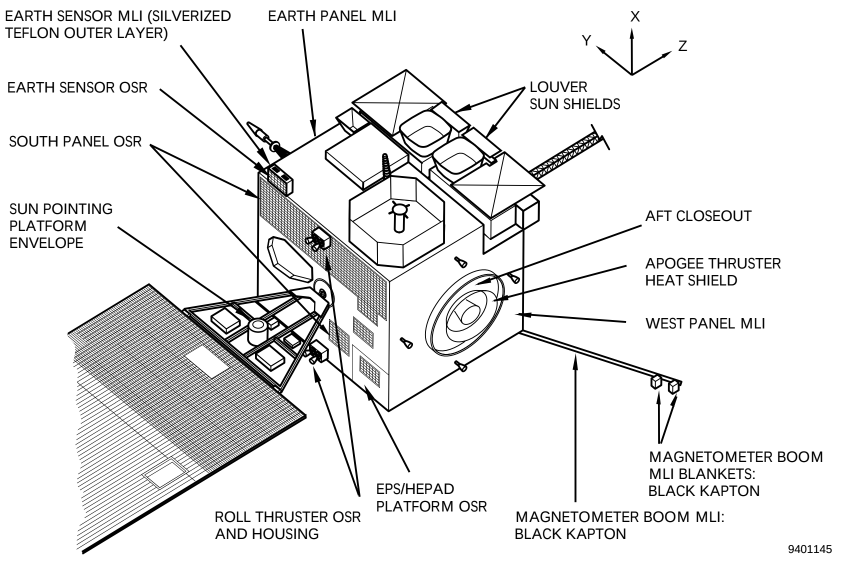
Thermal Control Subsystem

The thermal control subsystem design is configured for simple and reliable temperature control that provides the flexibility to accommodate variations in the spacecraft heat load. The approach to thermal control of the spacecraft uses conventional passive techniques such as selective placement of power dissipating components, application of surface finishes, and regulation of conductive heat paths. The passive design is augmented with heaters for certain components (particularly those with relatively narrow allowable temperature limits) and with louvers for the Imager and Sounder.

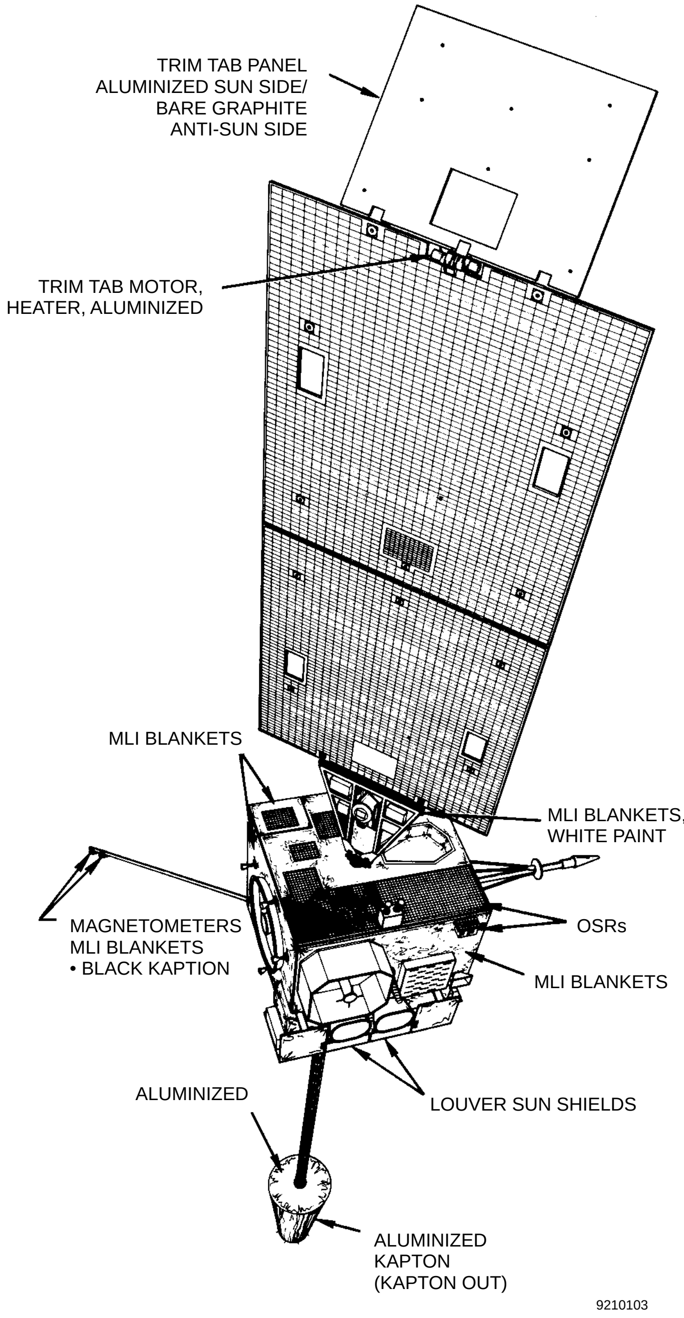
Thermal control is achieved with minimum heat transfer among the major parts of the spacecraft: the main body including energetic particles sensor / high energy particle and alpha detector; antenna; solar array including shunt; trim tab; X-ray sensor and positioner; magnetometers; Imager and Sounder; apogee thruster; and attitude and orbit control electronics. Thermal control of the main body is essentially independent of the Imager, Sounder, and appendages (antennas, magnetometers, solar array). Overall temperature control of the main body is achieved by:

- Thermal energy dissipation of components and compensation heaters in the main body
- Absorption of solar energy, particularly by the optical solar reflectors (OSRs) on the north and south panels
- Emission of infrared energy into space by the OSRs

Thermal Design - South/West/Earth Features



Thermal Design - Synchronous Orbit Configuration



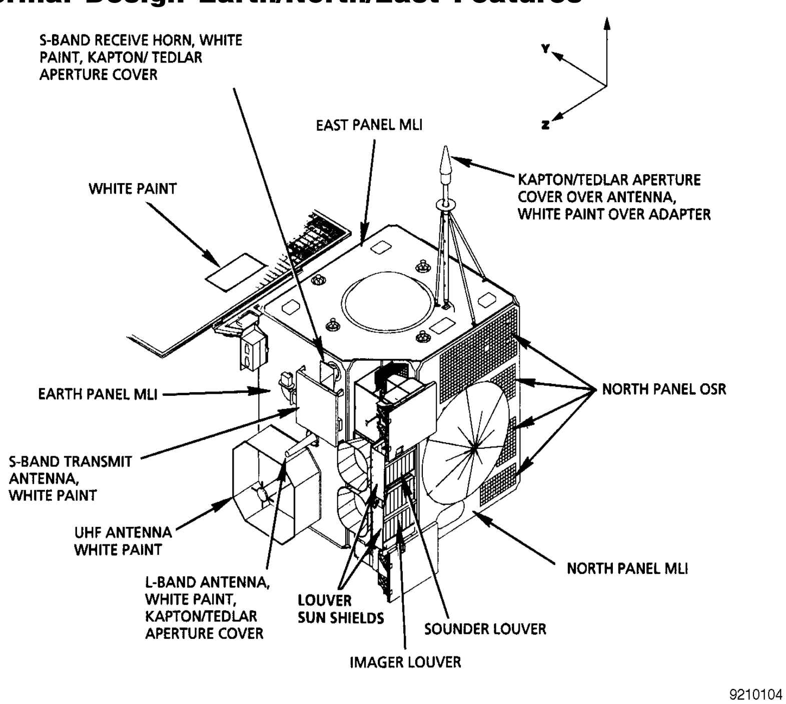
High thermal dissipators, such as S-band power amplifiers and digital integrating rate assemblies, are located on the north and south panels so that they may efficiently radiate their energy into space via heat sinks and OSRs.

Heaters are the basic means for temperature control of the spacecraft during all phases of transfer and synchronous orbit operations. The heater types and components to which they are applied are:

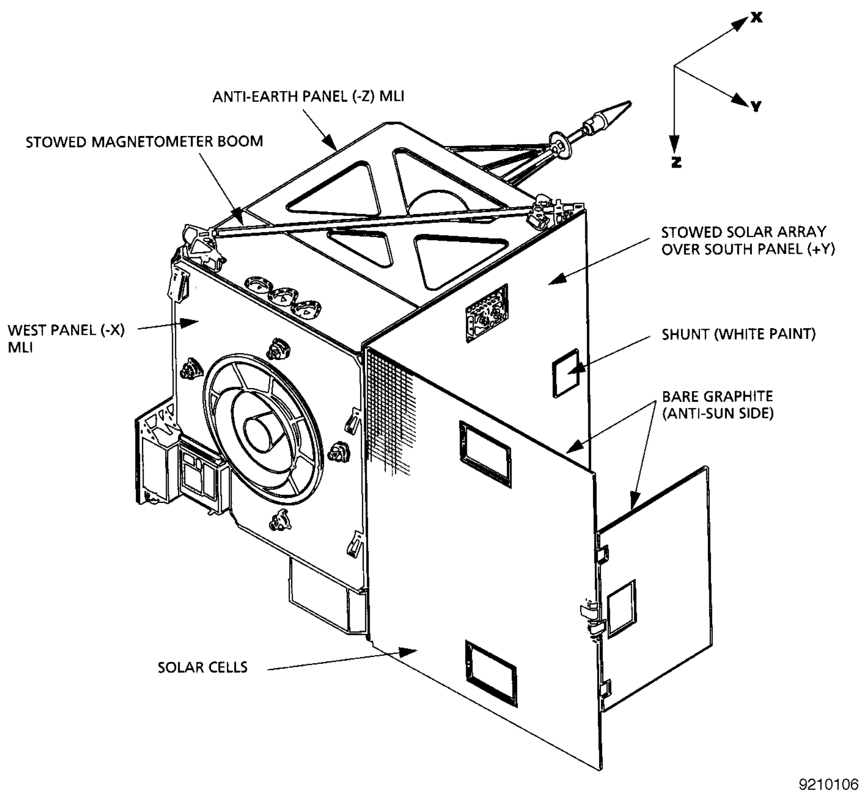
- Clayborn (adhesive-backed heater tape): fuel tank, oxidizer tank
- Tayco (patch heater): panel heaters, X-ray sensor
- Resistance wire: propulsion lines
- Dale resistors: thruster assemblies, batteries
- Proportional heaters: earth sensors, Imager, Sounder

Two types of temperature sensors are used: thermistors and platinum resistors. Thermistors are calibrated over two ranges: –40 to +70 °C with a resolution of ±1 °C, or –18 to +175 °C with a ±2 °C resolution. Thermistors are generally applied to electronic units whose typical operating range is –10 to +45 °C, with a non-operating range of –25 to +51 °C. They are also used extensively on propulsion components whose typical operating range is –3 to +165 °C. The platinum resistors have a range of –200 to +125 °C with a resolution of ±2 °C. These are used on components with wide temperature ranges such as the solar array, which has a range of –165 to +70 °C.

Thermal Design Earth/North/East Features



Thermal Design - Transfer Orbit Configuration



Imager and Sounder Thermal Control

Optical and radiometric performance of the Imager and Sounder are maintained throughout the 24-hour orbit by a combination of louver cooling and electrical heating. Thermal control is divided into two primary areas. First is thermal control for the sensor module as defined by the scan mirror and telescope assembly along with the optical bench or telescope baseplate and all structural sidewalls. Second is thermal design of the detector radiant cooler assembly; this is treated separately from the first inasmuch as these two components are intended to be adiabatic (thermally isolated) from each other; the thermal performance of one has little or no effect on the other.

Optical performance is maintained by restricting the total temperature range. Radiometric performance is maintained by limiting the temperature change between views of cold space (rate of change in temperature). Thermal control also contributes to channel registration and focus stability.

The basic thermal design concepts include:

- Maintaining the instruments as adiabatic as possible from the rest of the spacecraft structure.
- Controlling the temperature during the hot part of the synchronous orbit diurnal cycle (when direct solar heating is received into the scanner aperture) with a north-facing radiator whose net energy rejection capability is controlled by a louver system.
- Providing makeup heaters within the instruments to replace the infrared energy loss to space through the scanner aperture during the cold portion of the diurnal cycle.

Additionally, a sun shield is provided around the scan aperture (just outside the instrument field of view) to block incident solar radiation into the instruments, thus limiting the time in a synchronous orbit day when the scanner can receive direct solar energy. Uncontrolled temperature variations are reduced by the sun shield around the scan cavity opening, a passive automatic louver-controlled cooling surface, and electrical heating. Electrical heat decreases temperature excursions during the cold part of the daily cycle, but increases the average temperature. To obtain lower temperature ranges, louver-controlled cooling is provided during the direct sunlight portion of the orbit. A sun shield is installed on the earth end of the louver system to reduce incident radiation.

Multilayer insulation (MLI) blankets are applied on the outside of all but the north side of the instruments. The cover over the radiation cooler is designed to provide thermal protection of the radiation cooler patch during transfer orbit. This cover has MLI blankets on both sides and is deployed onto the earth face after reaching synchronous orbit.