Special Sensor Microwave Imager (SSM/I) Langley DAAC Sensor/Instrument Document

Abstract:

The Special Sensor Microwave Imager (SSM/I) Sensor is carried aboard Defense Meteorological Satellite Program (DMSP) satellites DMSP F-8, DMSP F-10, DMSP F-11, DMSP F-12, and DMSP F-13. This document will discuss the mission objectives, principles of operation, sensor specifications and calibration information of the SSM/I.

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1. Document Information:

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2. Instrument Information:

Instrument Long Name, Acronym:

Special Sensor Microwave Imager, SSM/I

Instrument Introduction:

The SSM/I is flown aboard Defense Meteorological Satellite Program (DMSP) satellites DMSP F-8, DMSP F-10, DMSP F-11, DMSP F-12, and DMSP F-13.

Instrument Mission Objectives:

The primary mission of the SSM/I instrument is to support Department of Defense (DoD) operations. The release of the data to the scientific community is a by-product of DoD support.

Key Variables:

The SSM/I is a seven-channel, four-frequency, linearly-polarized, passive microwave radiometric system which measures atmospheric, ocean and terrain microwave brightness temperatures at 19.35, 22.235, 37.0, and 85.5 GHz.

Scanning or Data Collections Concept/Principles of Operation:

The SSM/I rotates continuously about an axis parallel to the local spacecraft vertical and measures the upwelling scene brightness temperatures. The absolute brightness temperature of the scene incident upon the antenna is received and spatially filtered by the antenna to produce an effective input signal or antenna temperature at the input of the feedhorn antenna. The passive microwave radiometer output voltages are transmitted to both the Air Force Global Weather Central (AFGWC), Offutt Air Force Base, Nebraska and the Fleet Numerical Meteorology and Oceanography Center (FNMOC), Monterey California.

At both locations, the radiometer output voltages are converted to sensor counts. The AFGWC sensor counts are relayed to the National Environmental Satellite, Data, and Information Service (NESDIS), reformated into the NESDIS Level 1b format and used by NESDIS in generating temperature sounding data sets from another instrument. FNMOC converts their sensor counts into antenna temperatures(TDR), brightness temperatures(SDR), and derived geophysical parameters(EDR). The TDRs, SDRs, and EDRs are sent to NESDIS for archival. The FNMOC antenna temperatures are used as the basis for the SSM/I antenna temperature and geophysical parameter data sets produced by Remote Sensing Systems (Wentz data set).

3. Instrument Layout, Design, and Measurement Geometry:

List of Sensors:

Passive Microwave Radiometer

Sensor Descriptions:

The SSM/I instrument consists of an offset parabolic reflector of dimensions 24 x 26 inches, fed by a corrugated, broad-band, seven-port horn antenna. The reflector and feed are mounted on a drum which contains the radiometers, digital data subsystem, mechanical scanning subsystem, and power subsystem. The reflector-feed-drum assembly is rotated about the axis of the drum by a coaxially mounted bearing and power transfer assembly (BAPTA). All data, commands, timing and telemetry signals, and power pass through the BAPTA on slip ring connectors to the rotating assembly.

A small mirror and a hot reference absorber are mounted on the BAPTA and do not rotate with the drum assembly. They are positioned off axis such that they pass between the feed horn and the parabolic reflector, occulting the feed once each scan. The mirror reflects cold sky radiation into the feed, thus serving, along with the hot reference absorber, as calibration references for the SSM/I. This scheme provides an overall absolute calibration which includes the feed horn. Corrections for spillover and antenna pattern effects from the parabolic reflector are incorporated in the data processing algorithms.

The SSM/I rotates continuously about an axis parallel to the local spacecraft vertical at 31.6 rpm and measures the upwelling scene brightness temperatures over an angular sector of 102.4 deg about the sub-satellite track. The scan direction is from the left to the right when looking in the forward (F10,F11) or aft (F8) direction of the spacecraft with the active scene measurements lying ±51.2 deg about the forward (F10,F11) or aft (F8) direction. This results in a swath width of approximately 1400 km. The spin rate provides a period of 1.9 sec during which the spacecraft sub-satellite point travels 12.5 km. Each scan 128 discrete uniformly spaced radiometric samples are taken at the two 85 GHz channels and, on alternate scans, 64 discrete samples are taken at the remaining 5 lower frequency channels. The antenna beam intersects the Earth's surface at an incidence angle of 53.1 deg (as measured from the local Earth normal).

Sensor/Detector Specifications - Optics and Spacing:

A total-power radiometer configuration is employed in the SSM/I. The signal from the output of the feedhorn is down-converted by a balanced mixer, amplified, and converted to a video voltage with a square-law detector. The bandpass filter is used to define the receiver passband and to improve out-of-band rejection. The detected video signal is then amplified and offset to remove part of the component of receiver output due to receiver noise. The output of the video amplifier is integrated by an integrate and dump filter for 3.89 msec at 85 GHz and 7.95 msec for the remaining channels and delivered to the data processing system. The time between radiometer output samples is 4.22 msec at 85 GHz and is the same time required for the antenna beam to scan 12.5 km in the cross-track direction. The time between samples at the remaining frequencies is 8.44 msec.

The data processor multiplexes the seven radiometer output signals with an analog multiplexer and samples and holds the signals before being digitized into 12-bit words. In addition, 12 channels are multiplexed with the radiometer data. These channels contain three hot target temperature measurements, two temperature sensor measurements within the radiometer, reference voltage, and reference return data. A microprocessor supervises instrument timing, control, and data buffering with the DMSP Operational Line Scanner (OLS) instrument (collocated on the satellite) which records all SSM/I data. The average data rate of the SSM/I including zeros required to match the OLS interface is 3276 bps.

The SSM/I sensor weighs 107 lbs. A high speed momentum wheel weighing 16 lbs is mounted inside the spacecraft. The SSM/I system consumes 45 watts.

4. Manufacturer of Instrument:

Hughes Aircraft Company

5. Calibration:

Specifications:

The SSM/I instrument consists of an offset parabolic reflector of dimensions 24 x 26 inches, fed by a corrugated, broad-band, seven-port horn antenna. The reflector and feed are mounted on a drum which contains the radiometers, digital data subsystem, mechanical scanning subsystem, and power subsystem. The reflector-feed-drum assembly is rotated about the axis of the drum by a coaxially mounted bearing and power transfer assembly (BAPTA). All data, commands, timing and telemetry signals, and power pass through the BAPTA on slip ring connectors to the rotating assembly.

A small mirror and a hot reference absorber are mounted on the BAPTA and do not rotate with the drum assembly. They are positioned off axis such that they pass between the feed horn and the parabolic reflector, occulting the feed once each scan. The mirror reflects cold sky radiation into the feed, thus serving, along with the hot reference absorber, as calibration references for the SSM/I. This scheme provides an overall absolute calibration which includes the feed horn every 1.9 seconds. Corrections for spillover and antenna pattern effects from the parabolic reflector are incorporated in the data processing algorithms.

Tolerance:

Not available

Frequency of Calibration:

Once every 1.9 seconds

Other Calibration Information:

None

6. Glossary of Terms:

See the EOSDIS Glossary for a more general listing of terms related to the Earth Observing System project.

7. List of Acronyms:

- BAPTA - Bearing and Power Transfer Assembly
- DAAC - Distributed Active Archive Center
- DMSP - Defense Meteorological Satellite Program
- NASA - National Aeronautics and Space Administration
- NESDIS - National Environmental Satellite, Data, and Information Service
- OLS - Operational Line Scanner
- SSM/I - Special Sensor Microwave Imager

See the EOSDIS Acronyms for a more general listing of terms related to the Earth Observing System project.