Clouds and the Earth's Radiant Energy System

(CERES)

Data Management System

BiDirectional Scans (BDS) Collection Document

Release 3

Version 4

**Primary Authors**

*Denise L. Cooper, Phillip C. Hess*

Science Systems Applications, Inc. (SSAI)

One Enterprise Parkway, Suite 200

Hampton, Virginia 23666

*Jonathan L. Gleason*

NASA Langley Research Center

Climate Science Branch

Science Directorate

Building 1250

12 Langley Boulevard

Hampton, VA 23681-2199

*Kory J. Priestley*

NASA Langley Research Center

Climate Science Branch

Science Directorate

Building 1250

12 Langley Boulevard

Hampton, VA 23681-2199

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Document Revision Record

The Document Revision Record contains information pertaining to approved document changes. The table lists the date the Software Configuration Change Request (SCCR) was approved, the Release and Version Number, the SCCR number, a short description of the revision, and the revised sections. The document authors are listed on the cover. The Head of the CERES Data Management Team approves or disapproves the requested changes based on recommendations of the Configuration Control Board.

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Preface

The Clouds and the Earth’s Radiant Energy System (CERES) Data Management System supports the data processing needs of the CERES Science Team research to increase understanding of the Earth’s climate and radiant environment. The CERES Data Management Team works with the CERES Science Team to develop the software necessary to implement the science algorithms. This software, being developed to operate at the Langley Atmospheric Science Data Center (ASDC), produces an extensive set of science data products.

The Data Management System consists of 12 subsystems; each subsystem represents one or more stand-alone executable programs. Each subsystem executes when all of its required input data sets are available and produces one or more archival science products.

This Collection Guide is intended to give an overview of the science product along with definitions of each of the parameters included within the product. The document has been reviewed by the CERES Working Group teams responsible for producing the product and by the Working Group Teams who use the product.

Acknowledgement is given to Joanne H. Saunders of Science Systems and Applications, Inc. (SSAI) for her outstanding support in the preparation of this document.

[Document Revision Record ii](#_Toc356549355)

[Preface iii](#_Toc356549356)

[Summary 1](#_Toc356549357)

[1.0 Collection Overview 3](#_Toc356549358)

[1.1 Collection Identification 3](#_Toc356549359)

[1.2 Collection Introduction 4](#_Toc356549360)

[1.3 Objective/Purpose 4](#_Toc356549361)

[1.4 Summary of Parameters 6](#_Toc356549362)

[1.4.1 Science 6](#_Toc356549363)

[1.4.2 Instrument 8](#_Toc356549364)

[1.4.3 Level-0 11](#_Toc356549365)

[1.4.4 Metadata 15](#_Toc356549366)

[1.5 Discussion 15](#_Toc356549367)

[1.6 Related Collections 15](#_Toc356549368)

[2.0 Investigators 16](#_Toc356549369)

[2.1 Title of Investigation 16](#_Toc356549370)

[2.2 Contact Information 16](#_Toc356549371)

[3.0 Origination 17](#_Toc356549372)

[4.0 Data Description 18](#_Toc356549373)

[4.1 Spatial Characteristics 18](#_Toc356549374)

[4.1.1 Spatial Coverage 18](#_Toc356549375)

[4.1.2 Spatial Resolution 18](#_Toc356549376)

[4.2 Temporal Characteristics 18](#_Toc356549377)

[4.2.1 Temporal Coverage 18](#_Toc356549378)

[4.2.2 Temporal Resolution 19](#_Toc356549379)

[4.3 Data Characteristics 19](#_Toc356549380)

[4.3.1 Parameter/Variable 19](#_Toc356549381)

[4.3.2 Variable Description/Definition 19](#_Toc356549382)

[4.3.2.1 Science Parameter Descriptions 19](#_Toc356549383)

[4.3.2.2 Instrument Parameter Descriptions 43](#_Toc356549384)

[4.3.2.3 Level-0 Parameter Descriptions 60](#_Toc356549385)

[4.3.3 Fill Values 64](#_Toc356549386)

[4.3.4 Data Types 64](#_Toc356549387)

[5.0 Data Organization 66](#_Toc356549388)

[5.1 Data Granularity 66](#_Toc356549389)

[5.2 Data Format 66](#_Toc356549390)

[5.2.1 Scientific Data Sets (SDS) 66](#_Toc356549391)

[5.2.2 BDS SDS Summary 66](#_Toc356549392)

[5.2.3 Vertex Data (VData) 69](#_Toc356549393)

[5.2.3.1 Converted Instrument Status Data 69](#_Toc356549394)

[5.2.3.2 Converted Temperatures 70](#_Toc356549395)

[5.2.3.3 Converted Voltages and Torques 71](#_Toc356549396)

[5.2.3.4 Count Conversion Constants 72](#_Toc356549397)

[5.2.3.5 Position Counts 73](#_Toc356549398)

[5.2.3.6 Satellite - Celestial Data 74](#_Toc356549399)

[5.2.3.7 Temperature Counts 75](#_Toc356549400)

[5.2.3.8 Voltage - Torque Counts 76](#_Toc356549401)

[6.0 Theory of Measurements and Data Manipulations 78](#_Toc356549402)

[6.1 Theory of Measurements 78](#_Toc356549403)

[6.2 Data Processing Sequence 78](#_Toc356549404)

[6.3 Special Corrections/Adjustments 78](#_Toc356549405)

[6.3.1 Raw Sensor Count to Filtered Radiance Conversion Sequence 78](#_Toc356549406)

[6.3.2 Time Dependent Gain Correction. 81](#_Toc356549407)

[6.3.3 Spaceclamp and DAC Update Adjustment Algorithm 82](#_Toc356549408)

[6.3.4 Spurious Slow Mode Compensation 85](#_Toc356549409)

[6.3.5 Point Spread Function (PSF) lag algorithm 86](#_Toc356549410)

[6.3.6 Channel intercomparison tests 87](#_Toc356549411)

[6.3.7 Edit-limit and rate checks 88](#_Toc356549412)

[6.3.8 Window Channel SW Correction 89](#_Toc356549413)

[6.3.9 Packet Time Stamp Errors 89](#_Toc356549414)

[7.0 Errors 90](#_Toc356549415)

[7.1 Quality Assessment 90](#_Toc356549416)

[7.2 Data Validation by Source 90](#_Toc356549417)

[8.0 Notes 91](#_Toc356549418)

[9.0 Application of the Data Set 106](#_Toc356549419)

[10.0 Future Modifications and Plans 107](#_Toc356549420)

[11.0 Software Description 108](#_Toc356549421)

[12.0 Contact Data Center/Obtain Data 109](#_Toc356549422)

[13.0 Output Products and Availability 110](#_Toc356549423)

[14.0 References 111](#_Toc356549424)

[15.0 Glossary of Terms 112](#_Toc356549425)

[16.0 List of Acronyms 118](#_Toc356549426)

[17.0 Document Information 123](#_Toc356549427)

[17.1 Document Creation Date - February 1998 123](#_Toc356549428)

[17.2 Document Review Date - July 1998 123](#_Toc356549429)

[17.3 Document Revision Date 123](#_Toc356549430)

[17.4 Document ID 123](#_Toc356549431)

[17.5 Citation 123](#_Toc356549432)

[17.6 Redistribution of Data 123](#_Toc356549433)

[17.7 Document Curator 123](#_Toc356549434)

[Appendix A - CERES Metadata A-1](#_Toc356549435)

[Appendix B - Instrument Data Reference Material B-1](#_Toc356549436)

[B.1 Raw Digital Status Description B-1](#_Toc356549437)

[B.2 Digital Status Enumerations B-28](#_Toc356549438)

[B.3 CERES Instrument Commands B-32](#_Toc356549439)

[B.4 Analog Parameter Submultiplexer Channels B-55](#_Toc356549440)

[B.5 Flight Code Memory Description B-56](#_Toc356549441)

[B.6 Flight Code Heater Algorithm B-59](#_Toc356549442)

[Appendix C - Programmer Notes C-1](#_Toc356549443)

[C.1 Solar Avoidance System C-1](#_Toc356549444)

[Appendix D - Sensor Spurious Slow Mode Algorithm D-1](#_Toc356549445)

[Figure 1‑1. CERES Top Level Data Flow Diagram 5](#_Toc227562638)

[Figure 4‑1. Ancillary QA Flags Set 1 (Radiance Housekeeping) 20](#_Toc227562639)

[Figure 4‑2. Ancillary QA Flags Set 2 (Instrument Algorithm) 21](#_Toc227562640)

[Figure 4‑3. Viewing Angles at Surface or TOA 22](#_Toc227562641)

[Figure 4‑4. Clock Angle 24](#_Toc227562642)

[Figure 4‑5. Geocentric and Geodetic Colatitude/Longitude 25](#_Toc227562643)

[Figure 4‑6. Cone and Clock Angles 27](#_Toc227562644)

[Figure 4‑7. SDS format for mode dependent count offsets 27](#_Toc227562645)

[Figure 4‑8. Primary Scan Level QA Flags 30](#_Toc227562646)

[Figure 4‑9. Radiance and Mode Flags 33](#_Toc227562647)

[Figure 4‑10. Secondary Sample Level OA Flags 38](#_Toc227562648)

[Figure 4‑11. Secondary Scan Level QA Flag 39](#_Toc227562649)

[Figure 4‑12. Spacelook Average SDS Format 42](#_Toc227562650)

[Figure 4‑13. Azimuth Scan Profiles 46](#_Toc227562651)

[Figure 4‑14. Elevation Scan Profiles 48](#_Toc227562652)

[Figure 5‑1. BDS SDS schematic 66](#_Toc227562653)

[Figure 5‑2. Vdata record example 69](#_Toc227562654)

[Figure 5‑3. Count Conversion Constants Vdata Record Structure 73](#_Toc227562655)

[Figure 6‑1. Original Counts to Radiance Processing Flow 79](#_Toc227562656)

[Figure 6‑2. Counts to Radiance Processing Flow 80](#_Toc227562657)

[Figure 6‑3. Sensor Gain Drift 81](#_Toc227562658)

[Figure 6‑4. Typical Raw Instrument Signal 83](#_Toc227562659)

[Figure 6‑5. PFM Bridge Balance DAC Update Details 84](#_Toc227562660)

[Figure 8‑1. Scanner Footprint Geometry 96](#_Toc227562661)

[Figure 8‑2. CERES Field-of-View Angular Grid 97](#_Toc227562662)

[Figure 8‑3. Optical FOV 98](#_Toc227562663)

[Figure 15‑1. Subsolar Point 114](#_Toc227562664)

[Figure 15‑2. Ellipsoidal Earth Model 115](#_Toc227562665)

[Figure 15‑3. Subsatellite Point 116](#_Toc227562666)

[Figure 15‑4. Solar Eclipse Angles 117](#_Toc227562667)

[Figure 15‑5. Solar Eclipse Logic 117](#_Toc227562668)

[Figure B‑1. ICP and DAP Memory Maps (Aqua FM 4 Example) B-57](#_Toc227562669)

[Figure C‑1. Elevation Scan Angles C-2](#_Toc227562670)

[Figure D‑1. Radiometer and Electronics Block Diagram D-1](#_Toc227562671)

[Table 1‑1. BDS Collection Data Product File Names 3](#_Toc356397967)

[Table 1‑2. Science Parameters 6](#_Toc356397968)

[Table 1‑3. Instrument Parameters 8](#_Toc356397969)

[Table 1‑4. Level-0 Parameters 11](#_Toc356397970)

[Table 1‑5. BDS Metadata Summary 15](#_Toc356397971)

[Table 3‑1. CERES Instruments 17](#_Toc356397972)

[Table 4‑1. BDS Spatial Coverage 18](#_Toc356397973)

[Table 4‑2. BDS Temporal Coverage 18](#_Toc356397974)

[Table 4‑3. Ancillary QA Flags Set 1 (Radiance Housekeeping) 20](#_Toc356397975)

[Table 4‑4. Ancillary QA Flags Set 2 (Instrument Algorithm) 21](#_Toc356397976)

[Table 4‑5. Primary Scan Level QA Flags 31](#_Toc356397977)

[Table 4‑6. Radiance and Mode Quality Flags Definition 33](#_Toc356397978)

[Table 4‑7. Secondary Sample Level QA Flags 38](#_Toc356397979)

[Table 4‑8. Secondary Scan Level QA Flags 40](#_Toc356397980)

[Table 4‑9. Azimuth Default Normal and Solar Avoidance A/B Angles (Deg.) 44](#_Toc356397981)

[Table 4‑10. Azimuth Offset Correction Nominal Values (counts) 46](#_Toc356397982)

[Table 4‑11. Normal Earth Scan Elevation Profile 49](#_Toc356397983)

[Table 4‑12. Short Earth Scan Elevation Profile 49](#_Toc356397984)

[Table 4‑13. MAM Scan (Solar Calibration) Elevation Profile 50](#_Toc356397985)

[Table 4‑14. Alternate MAM Scan (Solar Calibration) Elevation Profile 50](#_Toc356397986)

[Table 4‑15. Nadir Earth Scan Elevation Profile 51](#_Toc356397987)

[Table 4‑16. Stowed Elevation Profile 51](#_Toc356397988)

[Table 4‑17. APID and Packet Format 57](#_Toc356397989)

[Table 4‑18. CERES Fill Values 65](#_Toc356397990)

[Table 4‑19. Data Types and Formats 65](#_Toc356397991)

[Table 5‑1. BDS Scientific Data Set (SDS) Summary 67](#_Toc356397992)

[Table 5‑2. Vdata Summary 69](#_Toc356397993)

[Table 5‑3. Converted Instrument Status Data Field Summary 70](#_Toc356397994)

[Table 5‑4. Converted Temperatures Field Summary 71](#_Toc356397995)

[Table 5‑5. Converted Voltages and Torques Field Summary 72](#_Toc356397996)

[Table 5‑6. Count Conversion Constants Field Summary 73](#_Toc356397997)

[Table 5‑7. Position Counts Field Summary 73](#_Toc356397998)

[Table 5‑8. Satellite - Celestial Data Field Summary 74](#_Toc356397999)

[Table 5‑9. Temperature Counts Field Summary 75](#_Toc356398000)

[Table 5‑10. Voltage - Torque Counts Field Summary 76](#_Toc356398001)

[Table 6‑1. Spaceclamp Validation Order 84](#_Toc356398002)

[Table 6‑2. Slow Mode Coefficients (; c) 86](#_Toc356398003)

[Table 6‑3. Applied PSF Lag Angle (Degrees) 87](#_Toc356398004)

[Table 6‑4. 3-Channel Inter-Comparison Coefficients 88](#_Toc356398005)

[Table 6‑5. Window Channel SW Correction Values 89](#_Toc356398006)

[Table 8‑1. Algorithm 1 Blackbody Coefficients 91](#_Toc356398007)

[Table 8‑2. Algorithm 2 Temperature Coefficients - Shortwave Channel 92](#_Toc356398008)

[Table 8‑3. Algorithm 2 Temperature Coefficients - Total Channel 92](#_Toc356398009)

[Table 8‑4. Algorithm 2 Temperature Coefficients - Window Channel 92](#_Toc356398010)

[Table 8‑5. Algorithm 4 Linear Coefficients 93](#_Toc356398011)

[Table 8‑6. Algorithm 4K Azimuth Gimbal Bias Coefficient (Counts) 94](#_Toc356398012)

[Table 8‑7. Detector Time Constant ( seconds, angular degrees) 100](#_Toc356398013)

[Table 8‑8. Julian Day Number 104](#_Toc356398014)

[Table A‑1. CERES Baseline Header Metadata A-1](#_Toc356484647)

[Table A‑2. CERES\_metadata Vdata A-3](#_Toc356484648)

[Table A‑3. BDS Product Specific Metadata Parameters A-3](#_Toc356484649)

[Table B‑1. Raw Digital Status Data B-1](#_Toc356484650)

[Table B‑2. Elevation Encoder Defined Offset (counts) B-15](#_Toc356484651)

[Table B‑3. Main Cover Default Position Values (counts) B-17](#_Toc356484652)

[Table B‑4. Main Cover Default Margin Values (counts) B-17](#_Toc356484653)

[Table B‑5. MAM Cover Default Position Values (counts) B-18](#_Toc356484654)

[Table B‑6. MAM Cover Default Margin Values (counts) B-18](#_Toc356484655)

[Table B‑7. ICP and DAP Expected RAM Values B-20](#_Toc356484656)

[Table B‑8. DAP and ICP ROM Code Checksums B-20](#_Toc356484657)

[Table B‑9. Brake Default Positions (counts) B-23](#_Toc356484658)

[Table B‑10. Digital Status Enumerations B-28](#_Toc356484659)

[Table B‑11. CERES Instrument Command Enumerations B-32](#_Toc356484660)

[Table B‑12. Azimuth Offset Compensating Bias Count Values B-40](#_Toc356484661)

[Table B‑13. Default Azimuth Goto Slew Rates (Deg/Sec) B-41](#_Toc356484662)

[Table B‑14. Default Azimuth Async Slew Rates (Deg/Sec) B-41](#_Toc356484663)

[Table B‑15. DAP Long Command Formats B-48](#_Toc356484664)

[Table B‑16. ICP Long Command Formats B-49](#_Toc356484665)

[Table B‑17. Allowable Sequence Mode Transition Table B-50](#_Toc356484666)

[Table B‑18. Instrument Commands Allowed by Mode B-51](#_Toc356484667)

[Table B‑19. Analog Parameter Submultiplexer Channels B-55](#_Toc356484668)

[Table B‑20. PFM (TRMM) Memory Patch Loads B-57](#_Toc356484669)

[Table B‑21. FM 1 (Terra) Memory Patch Loads B-57](#_Toc356484670)

[Table B‑22. FM 2 (Terra) Memory Patch Loads B-58](#_Toc356484671)

[Table B‑23. FM 3 (Aqua) Memory Patch Loads B-58](#_Toc356484672)

[Table B‑24. FM 4 (Aqua) Memory Patch Loads B-59](#_Toc356484673)

[Table B‑24a. FM 5 (S-NPP) Memory Patch Loads B-59](#_Toc356484674)

[Table B‑25. Heater Control Algorithm Default Coefficient Values B-60](#_Toc356484675)

Clouds and the Earth's Radiant Energy System (CERES)

BiDirectional Scans (BDS) Collection Document

Summary

The Clouds and the Earth’s Radiant Energy System (CERES) is a key component of the Earth Observing System (EOS) program. The CERES instrument provides radiometric measurements of the Earth's atmosphere from three broadband channels: a shortwave channel (0.3 - 5 m), a total channel (0.3 - 200 m), and an infrared window channel (8 - 12 m). The CERES instruments are improved models of the Earth Radiation Budget Experiment (ERBE) scanner instruments, which operated from 1984 through 1990 on the National Aeronautics and Space Administration’s (NASA) Earth Radiation Budget Satellite (ERBS) and on the National Oceanic and Atmospheric Administration’s (NOAA) operational weather satellites NOAA-9 and NOAA-10. The strategy of flying instruments on Sun-synchronous, polar orbiting satellites, such as NOAA-9 and NOAA-10, simultaneously with instruments on satellites that have precessing orbits in lower inclinations, such as ERBS, was successfully developed in ERBE to reduce time sampling errors. CERES continues that strategy by flying instruments on the polar orbiting EOS platforms (Terra and Aqua) and NOAA’s Joint Polar Satellite System (JPSS) Suomi-NPOESS Prepatory Platform (S-NPP) simultaneously with an instrument on the Tropical Rainfall Measuring Mission (TRMM) spacecraft, which has an orbital inclination of 35°. The TRMM and S-NPP satellites each carry one CERES instrument while the EOS satellites each carry two CERES instruments, one operating in a nominal fixed azimuth plane scanning mode (FAPS) for continuous Earth sampling and the other operating in a nominal rotating azimuth plane scan mode (RAPS) for improved angular sampling. The Terra and Aqua satellites orbit at a 705 km altitude with a 98.2° inclination. The Terra satellite nominally descends across the equator at 10:30 A.M. local. The Aqua satellite nominally ascends across the equator at 1:30 P.M. local. The S-NPP satellite nominally ascends across the equator at 1:30 P.M. at an altitude of 824 km and an inclination angle of 98.7°.

To preserve historical continuity, some parts of the CERES data reduction use algorithms identical with the algorithms used in ERBE. At the same time, many of the algorithms on CERES are new. To reduce the uncertainty in data interpretation and to improve the consistency between the cloud parameters and the radiation fields, CERES includes cloud imager data and other atmospheric parameters. The CERES investigation is designed to monitor the top-of-atmosphere radiation budget as defined by ERBE, to define the physical properties of clouds, to define the surface radiation budget, and to determine the divergence of energy throughout the atmosphere. The CERES Data Management System produces products which support research to increase understanding of the Earth’s climate and radiant environment.

Each BiDirectional Scans (BDS) data product contains twenty-four hours of Level-1b data for each CERES scanner instrument mounted on each spacecraft. The BDS includes samples taken in normal and short Earth scan elevation profiles in both fixed and rotating azimuth scan modes (including space, internal calibration, and solar calibration views). The BDS contains Level-0 raw (unconverted) science and instrument data as well as the geolocated converted science and instrument data. The BDS contains additional data not found in the Level-0 input file, including converted satellite position and velocity data, celestial data, converted digital status data, and parameters used in the radiance count conversion equations. This document provides information which describes the BDS collection for all CERES instruments.

# Collection Overview

## Collection Identification

The BDS Collection is made up of seven distinct data products. Their Product-ID and complete file names according to the CERES file naming convention are shown in .

Table ‑. BDS Collection Data Product File Names

|  |  |  |
| --- | --- | --- |
| Product-ID | File Name | External Distribution |
| BDS | CER\_BDS\_Sampling-Strategy\_Production-Strategy\_XXXXXX.YYYYMMDD | Yes |
| BDSS | CER\_BDSS\_Sampling-Strategy\_Production-Strategy\_XXXXXX.YYYYMMDD | No |
| BDSD | CER\_BDSD\_Sampling-Strategy\_Production-Strategy\_XXXXXX.YYYYMMDD | No |
| BDSG | CER\_BDSG\_Sampling-Strategy\_Production-Strategy\_XXXXXX.YYYYMMDD | No |
| BDSP | CER\_BDSP\_Sampling-Strategy\_Production-Strategy\_XXXXXX.YYYYMMDD | No |
| BDSM | CER\_BDSM\_Sampling-Strategy\_Production-Strategy\_XXXXXX.YYYYMMDD | No |
| BDSF | CER\_BDSF\_Sampling-Strategy\_Production-Strategy\_XXXXXX.YYYYMMDD | No |
| BDSI | CER\_BDSI\_Sampling-Strategy\_Production-Strategy\_XXXXXX.YYYYMMDD | No |

where:

CER Investigation designation for CERES,

BDS Product-ID for the primary science data product (external distribution),

BDSS Product-ID for the Solar calibration data product,

BDSD Product-ID for the Diagnostic science data product,

BDSF Product-ID for the Fixed pattern diagnostic data product,

BDSG Product-ID for the Gimbal diagnostic data product,

BDSM Product-ID for the Memory dump diagnostic data product,

BDSP Product-ID for the Processor diagnostic data product,

BDSI Product-ID of subsetted Internal Calibration data product,

Sampling-Strategy Platform and instrument (e.g., TRMM-PFM, Terra-FM1, Aqua-FM3, NPP-FM5),

Production-Strategy Edition or campaign reference (e.g., At-launch, Edition1, Edition2),\*\*

XXXXXX Configuration Code (CC) for file and software version management,

YYYY 4-digit calendar year integer,

MM 2-digit calendar month integer, and

DD 2-digit calendar day integer defining the data acquisition date.

\*\* **NOTE:** The Slow Mode and Drift Corrected Counts SDSs are only available on Edition1 BDS products with a configuration code of 027025 or greater, Edition2 BDS products with a configuration code of 028028 or greater, and all Edition3 BDS products.

## Collection Introduction

The BDS is a suite of distinct data products containing up to 24 hours of data from a single instrument and can consist of up to seven distinct products. The product available for external distribution is the BDS, the primary science product. The other products are used by the Instrument Working Group for investigating anomalies or instrument performance.

## Objective/Purpose

The overall science objectives of the CERES investigation are

1. For climate change research, provide a continuation of the ERBE record of radiative fluxes at the top of the atmosphere (TOA) that are analyzed using the same techniques used with existing ERBE data.
2. Double the accuracy of estimates of radiative fluxes at the TOA and the Earth’s surface from existing ERBE data.
3. Provide the first long-term global estimates of the radiative fluxes within the Earth’s atmosphere.
4. Provide cloud property estimates which are consistent with the radiative fluxes from surface to TOA.

The CERES Data Management System (DMS) is a software management and processing system which processes CERES instrument measurements and associated engineering data to produce archival science and other data products. The DMS is executed at the LaRC ASDC, which is also responsible for distributing the data products. A high-level view of the CERES DMS is illustrated by the CERES Top Level Data Flow Diagram shown in .

Grid TOA

and Surface

Fluxes:

Clouds

9

ERBE-like

Averaging to

Monthly TOA

Fluxes

3

Grid GEO

Narrowband

Radiances,

Clouds

11

GEO:

Geostationary

Narrowband

Radiances

Time  
Interpolate,  
Compute  
Fluxes

7

Grid

Radiative

Fluxes and

Clouds

6

MOA:

Meteorological,

Ozone, and

Aerosol Data

ES-8:

ERBE-like

Instantaneous  
TOA Estimates

ERBE-like

Inversion to

Instantaneous

TOA Fluxes

2

Regrid

Humidity

and

Temperature

Fields

12

BDS:

BiDirectional

Scans

SRBAVG:

Monthly

TOA/Surface Averages

SYNI:

Intermediate

Synoptic

Radiative

Fluxes and Clouds

Compute

Monthly and

Regional TOA

and Surface

Averages

10

Determine

Cloud

Properties, TOA

and Surface Fluxes

4

Geolocate

and Calibrate

Earth

Radiances

1

SSF: Single

Scanner Footprint TOA/Surface Fluxes and Clouds

CRS:   
Clouds

and Radiative

Swath

VIRS CID:

MODIS CID:

Cloud

Imager Data

SURFMAP:

Surface

Map

INSTR:

Instrument

Production Data Set

EID6:

ERBE-like Regional Data

AVG:

Monthly Regional

Radiative Fluxes

and Clouds

ZAVG:

Monthly Zonal and Global Radiative Fluxes and Clouds

Compute

Regional,

Zonal and

Global

Averages

8

GGEO:

Gridded GEO

Narrowband

Radiances, Clouds

FSW: Monthly

Gridded Radiative Fluxes and

Clouds

IES: Instrument

Earth Scans

CRH:

Clear

Reflectance

History

GAP:

Gridded Analysis Product

OPD:

Ozone

Profile

Data

MWH:

Microwave

Humidity

APD:

Aerosol

Data

SFC: Monthly

Gridded TOA/Surface

Fluxes and Clouds

ES-9:

ERBE-like

Monthly Regional Averages

ES-4:

ERBE-like  
Monthly Geographical Averages

Compute

Surface and

Atmospheric

Radiative

Fluxes

5

SYN

Synoptic

Radiative

Fluxes and Clouds

ISCCP-D2like-Day/Nit:

Monthly Gridded Cloud Averages

ISCCP-D2like-GEO:

Monthly Cloud Averages

Modified Date: October 2008

Figure ‑. CERES Top Level Data Flow Diagram

Circles in the diagram represent algorithm processes called subsystems, which are a logical collection of algorithms that together convert input products into output products. Boxes represent archival products or data stores which are designated as nonarchival or temporary data products. Boxes or data stores with arrows entering a circle are input sources for the subsystem, while boxes or data stores with arrows exiting the circles are output products.

## Summary of Parameters

The BDS parameters are divided into science, instrument, Level- 0, and metadata groupings only for discussion purposes in this document. The parameters within each grouping are listed in alphabetical order in the following sections. The parameter definitions are given in Section . Each parameter is mapped into the seven distinct BDS data products as shown in , , , and .

### Science

alphabetically lists the BDS science data, which are distributed to the science community and become the basis for higher-level science products. Information in the Link and Parameter Name columns are hyperlinked to the parameter definition found in Section Science Parameter Descriptions. The Link column identifier, SCI-n, refers to the science parameter grouping. The Structure Link column identifiers are links to a description of the Hierachical Data Format (HDF) structure and organization.

| Table ‑. Science Parameters | | | | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Link | Parameter Name | Structure Link | BDS | BDSS | BDSD | BDSF | BDSG | BDSM | BDSP | BDSI |
|  | Ancillary QA Flags Set 1 (Radiance Housekeeping) | Sec. | X | X | X |  | X | X | X |  |
|  | Ancillary QA Flags Set 2 (Spaceclamp Algorithm) | Sec. | X | X | X |  | X | X | X |  |
|  | CERES Relative Azimuth at Surface | Sec. | X | X | X |  | X | X | X | X |
|  | CERES Relative Azimuth at TOA - Geocentric | Sec. | X | X | X |  | X | X | X | X |
|  | CERES Solar Zenith at Surface | Sec. | X | X | X |  | X | X | X | X |
|  | CERES Solar Zenith at TOA - Geocentric | Sec. | X | X | X |  | X | X | X | X |
|  | CERES SW Filtered Radiance, Upwards | Sec. | X | X | X |  |  |  |  | X |
|  | CERES TOT Filtered Radiance, Upwards | Sec. | X | X | X |  |  |  |  | X |
|  | CERES Viewing Zenith at Surface | Sec. | X | X | X |  | X | X | X | X |
|  | CERES Viewing Zenith at TOA - Geocentric | Sec. | X | X | X |  | X | X | X | X |
|  | CERES WN Filtered Radiance, Upwards | Sec. | X | X | X |  |  |  |  | X |
|  | Clock Angle of CERES FOV at Satellite wrt Inertial Velocity | Sec. | X | X | X |  | X | X | X | X |
|  | Colatitude of CERES FOV at Surface | Sec. | X | X | X |  | X | X | X | X |
|  | Colatitude of CERES FOV at TOA | Sec. | X | X | X |  | X | X | X | X |
|  | Colatitude of Subsatellite Point at Surface at record end | Sec. | X | X | X | X | X | X | X | X |
|  | Colatitude of Subsatellite Point at Surface at record start | Sec. | X | X | X | X | X | X | X | X |
|  | Colatitude of Subsolar Point at Surface | Sec. | X | X | X | X | X | X | X | X |
|  | Colatitude of Sublunar Point at Surface | Sec. | X | X | X | X | X | X | X | X |
|  | Cone Angle of CERES FOV at Satellite | Sec. | X | X | X |  | X | X | X | X |
|  | Count Conversion SW Sample Offsets | Sec. | X | X | X |  |  |  |  | X |
|  | Count Conversion TOT Sample Offsets | Sec. | X | X | X |  |  |  |  | X |
|  | Count Conversion WN Sample Offsets | Sec. | X | X | X |  |  |  |  | X |
|  | Drift Corrected SW Counts | Sec. | X | X | X |  |  |  |  | X |
|  | Drift Corrected TOT Counts | Sec. | X | X | X |  |  |  |  | X |
|  | Drift Corrected WN Counts | Sec. | X | X | X |  |  |  |  | X |
|  | Earth-Sun Distance | Sec. | X | X | X | X | X | X | X | X |
|  | Earth-Moon Distance | Sec. | X | X | X | X | X | X | X | X |
|  | Julian Date and Time | Sec. | X | X | X | X | X | X | X | X |
|  | Longitude of CERES FOV at Surface | Sec. | X | X | X |  | X | X | X | X |
|  | Longitude of CERES FOV at TOA | Sec. | X | X | X |  | X | X | X | X |
|  | Longitude of Subsatellite Point at Surface at record end | Sec. | X | X | X | X | X | X | X | X |
|  | Longitude of Subsatellite Point at Surface at record start | Sec. | X | X | X | X | X | X | X | X |
|  | Longitude of Subsolar Point at Surface | Sec. | X | X | X | X | X | X | X | X |
|  | Longitude of Sublunar Point at Surface | Sec. | X | X | X | X | X | X | X | X |
|  | Lunar Azimuth Angles | Sec. | X | X | X |  |  |  |  | X |
|  | Lunar Elevation Angles | Sec. | X | X | X |  |  |  |  | X |
|  | Lunar Beta Angle at record start | Sec. | X | X | X | X | X | X | X | X |
|  | Lunar Eta Angle at record start | Sec. | X | X | X | X | X | X | X | X |
|  | Primary Scan Level QA Flags | Sec. | X | X | X |  | X | X | X | X |
|  | Radiance and Mode Flags | Sec. | X | X | X |  | X | X | X | X |
|  | Rate of Change of Clock Angle | Sec. | X | X | X |  | X | X | X | X |
|  | Rate of Change of Cone Angle | Sec. | X | X | X |  | X | X | X | X |
|  | Sample Aligned Analog Data | Sec. | X | X | X | X | X | X | X | X |
|  | Satellite Position at record end | Sec. | X | X | X | X | X | X | X | X |
|  | Satellite Position at record start | Sec. | X | X | X | X | X | X | X | X |
|  | Satellite Velocity at record end | Sec. | X | X | X | X | X | X | X | X |
|  | Satellite Velocity at record start | Sec. | X | X | X | X | X | X | X | X |
|  | Secondary Sample Level QA Flags | Sec. | X | X | X |  | X | X | X | X |
|  | Secondary Scan Level QA Flags | Sec. | X | X | X |  | X | X | X | X |
|  | Solar Beta Angle at Record Start | Sec. | X | X | X |  | X | X | X | X |
|  | Solar Eta Angle at Record Start | Sec. | X | X | X |  | X | X | X | X |
|  | Solar Azimuth Angles | Sec. | X | X | X |  |  |  |  | X |
|  | Solar Elevation Angles | Sec. | X | X | X |  |  |  |  | X |
|  | Solar Calibration MAM FOV Azimuth Angles | Sec. |  | X |  |  |  |  |  |  |
|  | Solar Calibration MAM FOV Elevation Angles | Sec. |  | X |  |  |  |  |  |  |
|  | SW Channel Spurious Slow Mode Constants | Sec. | X | X | X |  |  |  |  | X |
|  | TOT Channel Spurious Slow Mode Constants | Sec. | X | X | X |  |  |  |  | X |
|  | WN Channel Spurious Slow Mode Constants | Sec. | X | X | X |  |  |  |  | X |
|  | SW Channel Gain Constants | Sec. | X | X | X |  |  |  |  | X |
|  | TOT Channel Gain Constants | Sec. | X | X | X |  |  |  |  | X |
|  | WN Channel Gain Constants | Sec. | X | X | X |  |  |  |  | X |
|  | SW Radiance Edit Limits | Sec. | X | X | X |  |  |  |  | X |
|  | TOT Radiance Edit Limits | Sec. | X | X | X |  |  |  |  | X |
|  | WN Radiance Edit Limits | Sec. | X | X | X |  |  |  |  | X |
|  | SW Spaceclamp Values | Sec. | X | X | X |  |  |  |  | X |
|  | TOT Spaceclamp Values | Sec. | X | X | X |  |  |  |  | X |
|  | WN Spaceclamp Values | Sec. | X | X | X |  |  |  |  | X |
|  | SW Slow Mode and Drift Corrected Counts | Sec. | X | X | X |  |  |  |  | X |
|  | TOT Slow Mode and Drift Corrected Counts | Sec. | X | X | X |  |  |  |  | X |
|  | WN Slow Mode and Drift Corrected Counts | Sec. | X | X | X |  |  |  |  | X |
| \*\*These SDSs are available on Aqua and Terra Edition1 BDSs beginning with CC-Code 027025, Aqua and Terra Edition2 BDSs beginning with CC-Code 028028, and all Edition3 BDSs. | | | | | | | | | | |

### Instrument

alphabetically lists the BDS converted instrument engineering data, which are primarily intended for quality evaluation of the science parameters. While many of these parameters have both a raw and converted value, only one definition is given in Section Instrument Parameter Descriptions and is accessible by the Link and Parameter Name hyperlink columns. The Link column identifier, INS-n, refers to the instrument data grouping. The Structure Link column identifiers are links to a HDF organization description. The corresponding raw values (See ) are in different data structures than the converted values.

| Table ‑. Instrument Parameters | | | | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Link | Parameter Name | Structure Link | BDS | BDSS | BDSD | BDSF | BDSG | BDSM | BDSP | BDSI |
|  | ACA Electronics Temperature | Sec. | X | X | X |  | X | X | X | X |
|  | ACA Torque Output | Sec. | X | X | X |  | X | X | X | X |
|  | Azimuth Defined Asynchronous Scan Rate | Sec. | X | X | X | X | X | X | X | X |
|  | Azimuth Defined Crosstrack Position | Sec. | X | X | X | X | X | X | X | X |
|  | Azimuth Defined Fixed Cage Position | Sec. | X | X | X | X | X | X | X | X |
|  | Azimuth Defined Fixed Position A | Sec. | X | X | X | X | X | X | X | X |
|  | Azimuth Defined Fixed Position B | Sec. | X | X | X | X | X | X | X | X |
|  | Azimuth Defined Fixed Position Spare 1 | Sec. | X | X | X | X | X | X | X | X |
|  | Azimuth Defined Fixed Position Spare 2 | Sec. | X | X | X | X | X | X | X | X |
|  | Azimuth Defined Fixed Position Spare 3 | Sec. | X | X | X | X | X | X | X | X |
|  | Azimuth Defined Fixed Solar Calibration Position | Sec. | X | X | X | X | X | X | X | X |
|  | Azimuth Defined Normal Slew Rate | Sec. | X | X | X | X | X | X | X | X |
|  | Azimuth Defined Synchronous Scan Rate | Sec. | X | X | X | X | X | X | X | X |
|  | Azimuth Error | Sec. |  |  |  |  | X |  |  |  |
|  | Azimuth Lower Bearing Temperature | Sec. | X | X | X |  | X | X | X | X |
|  | Azimuth Offset Correction | Sec. | X | X | X | X | X | X | X | X |
|  | Azimuth Position Error | Sec. | X | X | X | X | X | X | X | X |
|  | Azimuth Upper Bearing Temperature | Sec. | X | X | X |  | X | X | X | X |
|  | Converted Azimuth Angles | Sec. | X | X | X |  | X | X | X | X |
|  | Converted Elevation Angles | Sec. | X | X | X |  | X | X | X | X |
|  | DAA +10V Reference | Sec. | X | X | X |  | X | X | X | X |
|  | DAA +12V | Sec. | X | X | X |  | X | X | X | X |
|  | DAA +130V | Sec. | X | X | X |  | X | X | X | X |
|  | DAA +15V | Sec. | X | X | X |  | X | X | X | X |
|  | DAA +5V | Sec. | X | X | X |  | X | X | X | X |
|  | DAA -10V Reference | Sec. | X | X | X |  | X | X | X | X |
|  | DAA -12V | Sec. | X | X | X |  | X | X | X | X |
|  | DAA -130V | Sec. | X | X | X |  | X | X | X | X |
|  | DAA -15V | Sec. | X | X | X |  | X | X | X | X |
|  | DAA ADC Electronics Temperature | Sec. | X | X | X |  | X | X | X | X |
|  | DAA Ground Reference 1 | Sec. | X | X | X |  | X | X | X | X |
|  | DAA Ground Reference 2 | Sec. | X | X | X |  | X | X | X | X |
|  | DAA Processor Electronics Temperature | Sec. | X | X | X |  | X | X | X | X |
|  | DAA Radiator Temperature | Sec. | X | X | X |  | X | X | X | X |
|  | DAP Maximum Execution Time | Sec. | X | X | X | X | X | X | X | X |
|  | DAP Minimum Execution Time | Sec. | X | X | X | X | X | X | X | X |
|  | DAP Timing | Sec. |  |  |  |  |  |  | X |  |
|  | Detector +120V Bias | Sec. | X | X | X |  | X | X | X | X |
|  | Detector -120V Bias | Sec. | X | X | X |  | X | X | X | X |
|  | ECA Electronics Temperature | Sec. | X | X | X |  | X | X | X | X |
|  | ECA Radiator Temperature | Sec. | X | X | X |  | X | X | X | X |
|  | ECA Torque Output | Sec. | X | X | X |  | X | X | X | X |
|  | Elevation Bearing Temperature-CW | Sec. | X | X | X |  | X | X | X | X |
|  | Elevation Bearing Temperature-Motor | Sec. | X | X | X |  | X | X | X | X |
|  | Elevation Error | Sec. |  |  |  |  | X |  |  |  |
|  | Elevation Offset Correction | Sec. | X | X | X | X | X | X | X | X |
|  | Elevation Spindle Temperature-CW | Sec. | X | X | X |  | X | X | X | X |
|  | Elevation Spindle Temperature-Motor | Sec. | X | X | X |  | X | X | X | X |
|  | ICA +10V Bias | Sec. | X | X | X |  | X | X | X | X |
|  | ICA +15V Internal | Sec. | X | X | X |  | X | X | X | X |
|  | ICA +15V to ECA/ACA | Sec. | X | X | X |  | X | X | X | X |
|  | ICA + 5V Analog | Sec. | X | X | X |  | X | X | X | X |
|  | ICA +5V Digital | Sec. | X | X | X |  | X | X | X | X |
|  | ICA -15V Internal | Sec. | X | X | X |  | X | X | X | X |
|  | ICA -15V to ECA/ACA | Sec. | X | X | X |  | X | X | X | X |
|  | ICA ADC Electronics Temperature | Sec. | X | X | X |  | X | X | X | X |
|  | ICA Processor Electronics Temperature | Sec. | X | X | X |  | X | X | X | X |
|  | ICA Radiator Temperature | Sec. | X | X | X |  | X | X | X | X |
|  | ICP Maximum Execution Time | Sec. | X | X | X | X | X | X | X | X |
|  | ICP Minimum Execution Time | Sec. | X | X | X | X | X | X | X | X |
|  | ICP Timing | Sec. |  |  |  |  |  |  | X |  |
|  | Instrument ID Number | Sec. | X | X | X | X | X | X | X | X |
|  | Main Cover Motor Temperature | Sec. | X | X | X |  | X | X | X | X |
|  | MAM Assembly SW Temperature | Sec. | X | X | X |  | X | X | X | X |
|  | MAM Assembly Total Temperature | Sec. | X | X | X |  | X | X | X | X |
|  | MAM Total Baffle Temperature 1 | Sec. | X | X | X |  | X | X | X | X |
|  | MAM Total Baffle Temperature 2 | Sec. | X | X | X |  | X | X | X | X |
|  | Packet Counter - Absolute | Sec. | X | X | X | X | X | X | X | X |
|  | Packet Counter - Relative | Sec. | X | X | X | X | X | X | X | X |
|  | Packet Data Indicator | Sec. | X | X | X | X | X | X | X | X |
|  | Packet Data Version | Sec. | X | X | X | X | X | X | X | X |
|  | Packet Timecode Indicator | Sec. | X | X | X | X | X | X | X | X |
|  | PCA Electronics Temperature | Sec. | X | X | X |  | X | X | X | X |
|  | PCA Radiator Temperature | Sec. | X | X | X |  | X | X | X | X |
|  | Pedestal Temperature 1-Brake Housing | Sec. | X | X | X |  | X | X | X | X |
|  | Pedestal Temperature 2-Isolator | Sec. | X | X | X |  | X | X | X | X |
|  | Science Packet Quick Look Status Flag | Sec. | X | X | X | X | X | X | X | X |
|  | Sensor Electronics Temperature | Sec. | X | X | X |  | X | X | X | X |
|  | Sensor Module Temperature | Sec. | X | X | X |  | X | X | X | X |
|  | SW Detector Control Temperature | Sec. | X | X | X |  | X | X | X | X |
|  | SW Detector Monitor Temperature | Sec. | X | X | X |  | X | X | X | X |
|  | SWICS Lamp Current | Sec. | X | X | X |  | X | X | X | X |
|  | SWICS Photodiode Temperature | Sec. | X | X | X |  | X | X | X | X |
|  | TOT Blackbody Temperature | Sec. | X | X | X |  | X | X | X | X |
|  | WN Detector Control Temperature | Sec. | X | X | X |  | X | X | X | X |
|  | TOT Detector Monitor Temperature | Sec. | X | X | X |  | X | X | X | X |
|  | WN Blackbody Temperature | Sec. | X | X | X |  | X | X | X | X |
|  | WN Detector Control Temperature | Sec. | X | X | X |  | X | X | X | X |
|  | WN Detector Monitor Temperature | Sec. | X | X | X |  | X | X | X | X |

### Level-0

alphabetically lists the Level-0 raw instrument science and engineering data, which are the fundamental digital measurements from the CERES instrument. The Link and Parameter Name column identifiers are hyperlinked to the parameter definition found in Section Level-0 Parameter Descriptions. The Link column identifier, LVL-n, refers to the Level-0 parameter grouping. The Structure Link column identifiers are links to a description of the HDF structure and organization.

| Table ‑. Level-0 Parameters | | | | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Link | Parameter Name | Structure Link | BDS | BDSS | BDSD | BDSF | BDSG | BDSM | BDSP | BDSI |
|  | ACA Electronics Temperature | Sec. | X | X | X |  | X | X | X | X |
|  | ACA Encoder Clear Track A | Sec. | X | X | X |  | X | X | X | X |
|  | ACA Encoder Clear Track B | Sec. | X | X | X |  | X | X | X | X |
|  | ACA Torque Output | Sec. | X | X | X |  | X | X | X | X |
|  | Azimuth Brake Position | Sec. | X | X | X |  | X | X | X | X |
|  | Azimuth Error Counts | Sec. |  |  |  |  | X |  |  |  |
|  | Azimuth Lower Bearing Temperature | Sec. | X | X | X |  | X | X | X | X |
|  | Azimuth Position Count | Sec. | X | X | X |  | X | X | X | X |
|  | Azimuth Upper Bearing Temperature | Sec. | X | X | X |  | X | X | X | X |
|  | Blackbody Heater DAC Value | Sec. | X | X | X |  | X | X | X | X |
|  | DAA +10V Reference | Sec. | X | X | X |  | X | X | X | X |
|  | DAA +12V | Sec. | X | X | X |  | X | X | X | X |
|  | DAA +130V | Sec. | X | X | X |  | X | X | X | X |
|  | DAA +15V | Sec. | X | X | X |  | X | X | X | X |
|  | DAA +5V | Sec. | X | X | X |  | X | X | X | X |
|  | DAA -10V Reference | Sec. | X | X | X |  | X | X | X | X |
|  | DAA -12V | Sec. | X | X | X |  | X | X | X | X |
|  | DAA -130V | Sec. | X | X | X |  | X | X | X | X |
|  | DAA -15V | Sec. | X | X | X |  | X | X | X | X |
|  | DAA ADC Electronics Temperature | Sec. | X | X | X |  | X | X | X | X |
|  | DAA Ground Reference 1 | Sec. | X | X | X |  | X | X | X | X |
|  | DAA Ground Reference 2 | Sec. | X | X | X |  | X | X | X | X |
|  | DAA Processor Electronics Temperature | Sec. | X | X | X |  | X | X | X | X |
|  | DAA Radiator Temperature | Sec. | X | X | X |  | X | X | X | X |
|  | DAP Memory | Sec. |  |  |  |  |  | X |  |  |
|  | DAP Timing Counts | Sec. |  |  |  |  |  |  | X |  |
|  | Detector +120V Bias | Sec. | X | X | X |  | X | X | X | X |
|  | Detector -120V Bias | Sec. | X | X | X |  | X | X | X | X |
|  | ECA Electronics Temperature | Sec. | X | X | X |  | X | X | X | X |
|  | ECA Radiator Temperature | Sec. | X | X | X |  | X | X | X | X |
|  | ECA Encoder Clear Track B | Sec. | X | X | X |  | X | X | X | X |
|  | ECA Radiator Temperature | Sec. | X | X | X |  | X | X | X | X |
|  | ECA Torque Output | Sec. | X | X | X |  | X | X | X | X |
|  | Elevation Spindle Temperature-CW | Sec. | X | X | X |  | X | X | X | X |
|  | Elevation Spindle Temperature-Motor | Sec. | X | X | X |  | X | X | X | X |
|  | Elevation Error Counts | Sec. |  |  |  |  | X |  |  |  |
|  | Elevation Position Count | Sec. | X | X | X |  | X | X | X | X |
|  | Elevation Spindle Temperature-CW | Sec. | X | X | X |  | X | X | X | X |
|  | Elevation Spindle Temperature-Motor | Sec. | X | X | X |  | X | X | X | X |
|  | Fixed Pattern 1 | Sec. |  |  |  | X |  |  |  |  |
|  | Fixed Pattern 2 | Sec. |  |  |  | X |  |  |  |  |
|  | Fixed Pattern 3 | Sec. |  |  |  | X |  |  |  |  |
|  | Fixed Pattern 4 | Sec. |  |  |  | X |  |  |  |  |
|  | Fixed Pattern 5 | Sec. |  |  |  | X |  |  |  |  |
|  | Fixed Pattern 6 | Sec. |  |  |  | X |  |  |  |  |
|  | ICA +10V Bias | Sec. | X | X | X |  | X | X | X | X |
|  | ICA +15V Internal | Sec. | X | X | X |  | X | X | X | X |
|  | ICA +15V to ECA/ACA | Sec. | X | X | X |  | X | X | X | X |
|  | ICA + 5V Analog | Sec. | X | X | X |  | X | X | X | X |
|  | ICA +5V Digital | Sec. | X | X | X |  | X | X | X | X |
|  | ICA -15V Internal | Sec. | X | X | X |  | X | X | X | X |
|  | ICA -15V to ECA/ACA | Sec. | X | X | X |  | X | X | X | X |
|  | ICA ADC Electronics Temperature | Sec. | X | X | X |  | X | X | X | X |
|  | ICA Processor Electronics Temperature | Sec. | X | X | X |  | X | X | X | X |
|  | ICA Radiator Temperature | Sec. | X | X | X |  | X | X | X | X |
|  | ICP Memory | Sec. |  |  |  |  |  | X |  |  |
|  | ICP Timing Counts | Sec. |  |  |  |  |  |  | X |  |
|  | Main Cover Motor Temperature | Sec. | X | X | X |  | X | X | X | X |
|  | Main Cover Position 1 | Sec. | X | X | X |  | X | X | X | X |
|  | Main Cover Position 2 | Sec. | X | X | X |  | X | X | X | X |
|  | MAM Assembly SW Temperature | Sec. | X | X | X |  | X | X | X | X |
|  | MAM Assembly Total Temperature | Sec. | X | X | X |  | X | X | X | X |
|  | MAM Cover Position | Sec. | X | X | X |  | X | X | X | X |
|  | MAM Total Baffle Temperature 1 | Sec. | X | X | X |  | X | X | X | X |
|  | MAM Total Baffle Temperature 2 | Sec. | X | X | X |  | X | X | X | X |
|  | PCA Electronics Temperature | Sec. | X | X | X |  | X | X | X | X |
|  | PCA Radiator Temperature | Sec. | X | X | X |  | X | X | X | X |
|  | Pedestal Temperature 1-Brake Housing | Sec. | X | X | X |  | X | X | X | X |
|  | Pedestal Temperature 2-Isolator | Sec. | X | X | X |  | X | X | X | X |
|  | Raw Instrument Status Data | Sec. | X | X | X | X | X | X | X | X |
|  | Sensor Electronics Temperature | Sec. | X | X | X |  | X | X | X | X |
|  | Sensor Module Temperature | Sec. | X | X | X |  | X | X | X | X |
|  | Spacecraft Time | Sec. |  |  |  |  |  | X |  |  |
|  | SPS 1 Narrow FOV | Sec. | X | X | X |  | X | X | X | X |
|  | SPS 1 Wide FOV | Sec. | X | X | X |  | X | X | X | X |
|  | SPS 2 Narrow FOV | Sec. | X | X | X |  | X | X | X | X |
|  | SPS 2 Wide FOV | Sec. | X | X | X |  | X | X | X | X |
|  | SW Channel Heater DAC Value | Sec. | X | X | X |  | X | X | X | X |
|  | SW Detector Control Temperature | Sec. | X | X | X |  | X | X | X | X |
|  | SW Detector Monitor Temperature | Sec. | X | X | X |  | X | X | X | X |
|  | SW Detector Outputs | Sec. | X | X | X |  |  |  |  | X |
|  | SWICS Lamp Current | Sec. | X | X | X |  | X | X | X | X |
|  | SWICS Photodiode Output | Sec. | X | X | X |  | X | X | X | X |
|  | SWICS Photodiode Temperature | Sec. | X | X | X |  | X | X | X | X |
|  | TOT Detector Outputs | Sec. | X | X | X |  |  |  |  | X |
|  | TOT Blackbody Temperature | Sec. | X | X | X |  | X | X | X | X |
|  | Total Channel Heater DAC Value | Sec. | X | X | X |  | X | X | X | X |
|  | TOT Detector Control Temperature | Sec. | X | X | X |  | X | X | X | X |
|  | TOT Detector Monitor Temperature | Sec. | X | X | X |  | X | X | X | X |
|  | WN Blackbody Temperature | Sec. | X | X | X |  | X | X | X | X |
|  | WN Channel Heater DAC Value | Sec. | X | X | X |  | X | X | X | X |
|  | WN Detector Control Temperature | Sec. | X | X | X |  | X | X | X | X |
|  | WN Detector Monitor Temperature | Sec. | X | X | X |  | X | X | X | X |
|  | WN Detector Outputs | Sec. | X | X | X |  |  |  |  | X |

### Metadata

The BDS metadata is summarized in and the detailed listings are in .

Table ‑. BDS Metadata Summary

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Description Table | HDF Name | BDS | BDSS | BDSD | BDSF | BDSG | BDSM | BDSP | BDSI |
|  | CERES Baseline Header Metadata | X | X | X | X | X | X | X | X |
|  | CERES\_metadata Vdata | X | X | X | X | X | X | X | X |
|  | BDS Product Specific Metadata | X | X | X | X | X | X | X | X |

## Discussion

The Geolocate and Calibrate Earth Radiances or Instrument Subsystem (SS1.0) is the first data processing unit in the CERES Data Management System. The primary input data set is a 24-hour, Level-0 instrument data stream of chronologically-ordered data packets. Each packet contains a full 6.6 second scan cycle of measurement data from the three broadband radiometric channels. The radiance measurements are sampled and output every 0.01 second while engineering data are sampled at least once in each scan cycle. Examples of the engineering data are elevation and azimuth positions, voltage and temperature measurements, and instrument status information. SS1.0 converts the Level-0 digital count data into geolocated and calibrated spectrally filtered radiances for the three radiometric channels. The Level-0 orbit ephemeris and spacecraft attitude data along with the elevation and azimuth positions are used to compute the science measurement geolocation. SS1.0 also converts all instrument engineering and spacecraft ephemeris data into engineering units. A post-processing program extracts a subset of BDS parameters (called a Pre-ES8) for input to the ERBE-like Subsystem 2.0. Subsystem 1.0 also produces the IES product which is input to the Cloud Subsystem 4.0.

## Related Collections

See the CERES Data Products Catalog (Reference ) for a complete product listing.

# Investigators

Dr. Norman G. Loeb, CERES Principal Investigator

Mail Stop 420

Atmospheric Sciences Division Building 1250

21 Langley Boulevard

NASA Langley Research Center

Hampton, Virginia 23681-2199

Telephone: (757) 864-5688

FAX: (757) 864-7996

E-mail: norman.g.loeb@nasa.gov

## Title of Investigation

Geolocate and Calibrate Earth Radiances (Subsystem 1.0)

## Contact Information

Dr. Kory Priestley, Instrument Working Group Chair

Mail Stop 420

Atmospheric Sciences Division Building 1250

21 Langley Boulevard

NASA Langley Research Center

Hampton, Virginia 23681-2199

Telephone: (757) 864-8147

FAX: (757) 864-7996

E-mail: kory.j.priestley@nasa.gov

# Origination

The CERES data originate from CERES instruments on-board the TRM, the EOS Earth-orbiting spacecrafts, Terra and Aqua, or the JPSS S-NPP spacecraft. lists the CERES instruments and their host satellites.

Table ‑. CERES Instruments

|  |  |  |
| --- | --- | --- |
| Satellite | CERES Instruments | |
| TRMM | ProtoFlight Model [PFM] | |
| Terra | Flight Model 1 [FM 1]  (operationally designated "CEF") | Flight Model 2 [FM 2]  (operationally designated "CEA") |
| Aqua | Flight Model 3 [FM 3]  (operationally designated "CEA") | Flight Model 4 [FM 4]  (operationally designated "CEF") |
| S-NPP | Flight Model 5 [FM 5]  (operationall designated “CE”) | |

The CERES instrument contains three scanning thermistor bolometer radiometers that measure the radiation in the near-visible through far-infrared spectral region. The shortwave detector measures Earth-reflected and Earth-emitted solar radiation and the window detector measures Earth-emitted longwave radiation in the water vapor window. The total detector measures total Earth-reflected and Earth-emitted radiance. The detectors are coaligned and mounted on a spindle that rotates about the instrument elevation axis. The resolution of the CERES radiometers is usually referenced to the optical FOV (See ).

The CERES instrument has an operational scanning cycle of 6.6 seconds and various scan elevation profiles. Radiometric measurements are sampled from the detectors every 0.01 seconds in all scanning profiles. The instrument makes Earth-viewing science measurements while the detectors rotate in the vertical (elevation scan) plane, and while the instrument horizontal (azimuth scan) plane is either fixed or rotating. The instrument has built-in calibration sources for performing in-flight calibrations, and can also be calibrated by measuring solar radiances reflected by a solar diffuser plate into the instrument field of view. See the In-flight Measurement Analysis document, DRL 64, provided by the CERES instrument builder TRW (Reference ), and the CERES Algorithm Theoretical Basis Document (ATBD) for Subsystem 1.0 (Reference ).

# Data Description

## Spatial Characteristics

### Spatial Coverage

The BDS collection is a global data set whose spatial coverage depends on the satellite orbit as shown in . The BDS contains all daily orbital swaths of CERES footprint data.

Table ‑. BDS Spatial Coverage

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Spacecraft: Instrument(s) | Minimum Latitude (deg) | Maximum Latitude (deg) | Minimum Longitude (deg) | Maximum Longitude (deg) | Spacecraft Altitude (km) |
| TRMM: PFM | -52 | 52 | -180 | 180 | 350 |
| Terra: FM 1 & FM 2 | -90 | 90 | -180 | 180 | 705 |
| Aqua: FM 3 & FM 4 | -90 | 90 | -180 | 180 | 705 |
| S-NPP: FM 5 | -90 | 90 | -180 | 180 | 824 |

### Spatial Resolution

Each BDS record represents 660 CERES measurements. The spatial scale of each measurement or footprint varies with the viewing zenith. The resolution of the CERES radiometers is usually referenced to the optical FOV (See ).

## Temporal Characteristics

### Temporal Coverage

The BDS temporal coverage begins after the spacecraft is launched, the scan covers are opened, and the early in-orbit calibration check-out is completed (See ).

Table ‑. BDS Temporal Coverage

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Spacecraft | Instrument | Launch Date | Start Date | End Date |
| TRMM | PFM | 11/27/1997 | 12/27/1997 | 8/31/1998\* |
| Terra | FM 1 & FM 2 | 12/18/1999 | 2/26/2002 | present |
| Aqua | FM 3 & FM 4 | 5/4/2002 | 6/26/2002 | present |
| S-NPP | FM 5 | 10/28/2011 | 1/27/2012 | present |

\* The PFM instrument operated intermittently since 1 September, 1998 due to a power converter anomaly in the data acquisition electronics. PFM resumed crosstrack operations on 26 February, 2000. Radiometric coverage continued until 5 April, 2000 when electronic noise caused too much corruption for meaningful science results. A complete loss of radiance data occurred on 14 June, 2000 due to thermal shutdown of the analog-to-digital converter electronics believed to be induced by the failed power converter.

### Temporal Resolution

The CERES instrument is expected to be operational throughout the TRMM and EOS mission lifetimes. Since BDS products are produced whenever the CERES instruments are operational, a continuous global data collection is expected. Each BDS measurement within a record represents a radiometric measurement taken every 0.01 seconds, and each record covers 6.6 seconds.

## Data Characteristics

### Parameter/Variable

The complete alphabetical listings of BDS parameters are shown in Section in , , and and correspond to the science, instrument, and Level-0 groupings, respectively. The parameter descriptions beginning in the next section are also organized by science (SCI), instrument (INS), and Level-0 (LVL) groupings where SCI, INS, and LVL are acronyms denoting the particular data grouping. Listed for each definition are the (units), [range], and a {link} to the section describing the parameter structure as it is written to the output product. The ranges are considered nominal values unless specified otherwise. For example, if a parameter has an associated QA flag, a non-nominal range may have been used for quality testing.

### Variable Description/Definition

#### Science Parameter Descriptions

The CERES science parameters are computed using the geodetic coordinate system. However, several parameters are computed in the geocentric coordinate system, and will specifically include the term "geocentric" in the parameter name. The geocentric parameters are used by the ERBE-like Subsystems since ERBE products are archived in the geocentric coordinate system. An alphabetical listing of the science parameters is shown in .

**SCI-1 Ancillary QA Flags Set 1 (Radiance Housekeeping)**

This parameter is a 32-bit word that contains various quality assurance flags about scan and measurement level data that are used in the radiance conversion algorithm. The status word bit ordering is shown in , where zero is the least significant bit. Note: beginning with CC version 016011 BDS products, this parameter was discontinued. Individual flags were reassigned to the Primary\_Scan\_Level\_QA\_Flags, Secondary\_Scan\_Level\_QA\_Flags, and Secondary\_Sample\_Level\_QA\_Flags parameters. (none) [N/A] {Section BDS SDS Summary}

0

31

32-Bit Word

Spare

WN Radiance Edit

WN Heatsink Temp Edit

SW Heatsink Temp Edit

TOT Heatsink Temp Edit

WN DAC Voltage Edit

SW DAC Voltage Edit

1

2

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

19

20

21

2

23

24

25

26

27

28

29

30

SW Radiance Edit

TOT Radiance Edit

TOT DAC Voltage Edit

Bias Voltage Edit

Always 0

Main Cover Status

MAM Cover Status

Elevation Profile ID

Figure 4‑1. Ancillary QA Flags Set 1 (Radiance Housekeeping)

The individual flags are identified in with links to their descriptions.

Table ‑. Ancillary QA Flags Set 1 (Radiance Housekeeping)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Item** | Bits | Flag Parameter Name | **Item** | Bits | Flag Parameter Name |
|  | 0 | Spares. Set to zero |  | 16 .. 17 | TOT Heatsink Temperature Edit Check: |
|  | 1 .. 5 | Elevation Profile ID: |  | 18 .. 19 | SW Heatsink Temperature Edit Check: |
|  | 6 | MAM Cover Status: |  | 20 .. 21 | WN Heatsink Temperature Edit Check: |
|  | 7 | Main Cover Status: |  | 22 .. 24 | TOT Radiance Edit Check: |
|  | 8 .. 9 | Bias Voltage Edit Check: |  | 25 .. 27 | SW Radiance Edit Check: |
|  | 10 .. 11 | TOT DAC Voltage Edit Check: |  | 28 .. 30 | WN Radiance Edit Check: |
|  | 12 .. 13 | SW DAC Voltage Edit Check: |  | 31 | N/A; Set to zero |
|  | 14 .. 15 | WN DAC Voltage Edit Check: |  |  |  |

**SCI-2 Ancillary QA Flags Set 2 (Spaceclamp Algorithm)**

This 32-bit word contains information about measurement level data that are used in the radiance conversion algorithm. The bit ordering of the status word is shown below in . Note: beginning with CC version 016011 BDS products, this parameter was discontinued. Individual flags were reassigned to the Primary\_Scan\_Level\_QA\_Flags, Secondary\_Scan\_Level\_QA\_Flags, and Secondary\_Sample\_Level\_QA\_Flags parameters.

(none) [N/A] {Section BDS SDS Summary}

Figure 4‑2. Ancillary QA Flags Set 2 (Instrument Algorithm)

0

31

32-Bit Word

Spares

WN Space Clamp

1

2

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

19

20

21

22

23

24

25

26

27

28

29

30

SW Space Clamp

TOT Space Clamp

Used In SpaceClamp

Always 0

SW 2nd TC Vk Status

TOT 2nd TC Vk Status

SW DAC Status

TOT DAC Status

WN DAC Status

WN 2nd TC Vk Status

The individual flags are identified in with links to their descriptions.

Table ‑. Ancillary QA Flags Set 2 (Instrument Algorithm)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Item | Bits | Flag Parameter | Item | Bits | Flag Parameter |
|  | 0 .. 2 | Spares. Set to zero |  | 17 .. 20 | SW SpaceClamp Status: |
|  | 3 .. 5 | TOT 2nd Time Constant Vk Status: |  | 21 .. 24 | WN SpaceClamp Status: |
|  | 6 .. 8 | SW 2nd Time Constant Vk Status: |  | 25 .. 26 | TOT DAC Status: |
|  | 9 .. 11 | WN 2nd Time Constant Vk Status: |  | 27 .. 28 | SW DAC Status: |
|  | 12 .. 12 | Measurement Used in Spaceclamp: |  | 29 .. 30 | WN DAC Status: |
|  | 13 .. 16 | TOT SpaceClamp Status: |  | 31 | N/A; Set to zero |

**SCI-3 CERES Relative Azimuth at Surface**

This parameter is the geodetic azimuth angle φ (See ) at the Earth point (See ) of the satellite relative to the solar plane. (deg) [0 .. 360] {Section BDS SDS Summary}

Sun

Zenith (geodetic or geocentric)







Satellite

Plane

normal

to Zenith

Forward

Scatter

Solar

Plane

Earth Point or

TOA Point

Figure ‑. Viewing Angles at Surface or TOA

The relative azimuth is measured clockwise in the plane normal to the geodetic zenith (See ) so that the relative azimuth of the Sun is always 180o. The solar plane is the plane which contains the geodetic zenith vector and a vector from the Earth point to the Sun. If the Earth point is north of the geodetic subsolar point (See ) on the same meridian, then an azimuth of 90o would imply the satellite is east of the Earth point.

**SCI-4 CERES Relative Azimuth at TOA - Geocentric**

This parameter is the geocentric azimuth angle  (See ) at the TOA point (See ) of the satellite relative to the solar plane. (deg) [0 .. 360] {Section BDS SDS Summary}

The relative azimuth is measured clockwise in the plane normal to the geocentric zenith (See ) so that the relative azimuth of the Sun is always 180o. The solar plane is the plane which contains the geocentric zenith vector and a vector from the TOA point to the Sun. If the TOA point is north of the geocentric subsolar point (See ) on the same meridian, then an azimuth of 90o would imply the satellite is east of the target point.

**SCI-5 CERES Solar Zenith at Surface**

This parameter is the geodetic zenith angle  (See ) at the Earth point (See ) of the Sun. (deg) [0 .. 180] {Section BDS SDS Summary}

The geodetic solar zenith is the angle between the geodetic zenith (See ) vector and a vector from the Earth point to the Sun.

**SCI-6 CERES Solar Zenith at TOA - Geocentric**

This parameter is the geocentric zenith angle  (See ) at the TOA point (See ) of the Sun. (deg) [0 .. 180] {Section BDS SDS Summary}

The geocentric solar zenith is the angle between the geocentric zenith (See ) vector and a vector from the TOA point to the Sun.

**SCI-7 CERES SW Filtered Radiance, Upwards**

The CERES SW filtered radiance is the measured, spectrally integrated radiance emerging from the TOA (See ), where the spectral integration is weighted by the spectral throughput of the SW channel. It is the measurement from the SW channel after count conversion (Reference ). (Wm-2 sr-1) [-5 .. 375] {Section BDS SDS Summary}

The SW filtered radiance is a measure of all radiance that passes through the SW channel. The spectral weighting produced by the SW channel throughput is the product of the SW filter throughput and the TOT channel throughput (See ). The SW spectral throughput passes about 75% of the radiant power with wavelengths shorter than 5 m and cuts off sharply at about 5 m. Wavelengths longer than this wavelength contribute a very small fraction of this measurement. The SW filtered radiance value is defined as either “good” or “bad” by the Radiance and Mode Flags (See ). If the value is “bad”, for any reason, the SW filtered radiance is set to a default fill value. If the value is “good”, the measured value is retained.

**SCI-8 CERES TOT Filtered Radiance, Upwards**

The CERES TOT filtered radiance is the measured, spectrally integrated radiance emerging from the TOA, where the spectral integration is weighted by the spectral throughput of the TOT channel. It is the measurement from the TOT channel after count conversion (Reference ). (Wm-2 sr-1) [-5 .. 420] {Section BDS SDS Summary}

The TOT filtered radiance is a measure of all radiance that passes through the TOT channel. The spectral weighting produced by the TOT channel throughput is the product of the primary mirror reflectance, the secondary mirror reflectance, and the absorptance of the detector flake. The TOT spectral throughput passes about 90% of the radiant power with wavelengths longer than 5m and about 85% of the power with shorter wavelengths. The filtered TOT radiance value is defined as either “good” or “bad” by the Radiance and Mode Flags (See ). If the value is “bad”, for any reason, the TOT filtered radiance is set to a default fill value. If the value is “good”, the measured value is retained.

**SCI-9 CERES Viewing Zenith at Surface**

This parameter is the geodetic angle  (See ) at the Earth point (See ) to the satellite. (deg) [0 .. 90] {Section BDS SDS Summary}

The geodetic viewing zenith is the angle between the geodetic zenith (See ) vector and a vector from the Earth point to the satellite.

**SCI-10 CERES Viewing Zenith at TOA - Geocentric**

This parameter is the geocentric angle  (See ) at the TOA point (See ) to the satellite. (deg) [0 .. 90] {Section BDS SDS Summary}

The geocentric viewing zenith is the angle between the geocentric zenith (See ) vector and a vector from the TOA point to the satellite.

**SCI-11 CERES WN Filtered Radiance, Upwards**

The CERES WN filtered radiance is a measured, spectrally integrated radiance emerging from the TOA, where the spectral integration is weighted by the spectral throughput of the WN channel. It has a bandpass from approximately 8 to 12 m. It is the measurement from the window channel after count conversion (Reference ). (Wm-2 sr-1) [-2 .. 105] {Section BDS SDS Summary}

The WN filtered radiance is a measure of all radiance that passes through the WN channel. The spectral weighting produced by the WN channel throughput is the product of the WN filter throughput and the TOT channel throughput (See ). The WN spectral throughput passes about 67% of the radiant power between 8 to 12 m. The filtered WN radiance value is defined as either “good” or “bad” by the Radiance and Mode Flags (). If the value is “bad”, for any reason, the WN filtered radiance is set to a default fill value. If the value is “good”, the measured value is retained.

**SCI-12 Clock Angle of CERES FOV at Satellite wrt Inertial Velocity**

The clock angle (See and ) is the azimuth angle of the instrument view vector from the satellite to the Earth point (See ) relative to the inertial velocity vector. (deg) [0 .. 360] {Section BDS SDS Summary}



Figure ‑. Clock Angle

The clock angle, along with the cone angle (See and ) define the direction of the instrument view vector to the Earth point.

The clock angle  is defined in a right-handed coordinate system centered at the satellite where z is toward the center of the Earth, x is in the direction of the inertial velocity vector, and y completes the triad. When  = 270o, the Earth point is on the same side of the orbit as the orbital angular momentum vector (See ). When  = 0o, the Earth point is directly ahead of the satellite. This is true when the spacecraft is flying in the +x axis forward orientation. For TRMM, the spacecraft will need to fly -x axis forward whenever the Solar beta angle is less than zero. Under these conditions, the sign of this clock angle will be negative.

The toolkit call (See Reference ) PGS\_CSC\_SCtoORB transforms the instrument view vector in spacecraft coordinates to (x,y,z) orbital coordinates and the clock angle is defined by

, , and .

**SCI-13 Colatitude of CERES** FOV **at Surface**

This parameter is the geodetic colatitude angle d (See ) of the Earth point (See ). (deg) [0 .. 180] {Section BDS SDS Summary}

The geodetic colatitude is the angle between the geodetic zenith (See ) at the Earth point and a vector normal to the Earth equator toward the North pole as defined in the Earth equator, Greenwich meridian system (See ).

**SCI-14 Colatitude of CERES** FOV **at TOA**

This parameter is the geodetic colatitude angle c (See ) of the TOA point (See ). (deg) [0 .. 180] {Section BDS SDS Summary}



Figure ‑. Geocentric and Geodetic Colatitude/Longitude

The geodetic colatitude is the angle between the geodetic zenith (See ) at the TOA point and a vector normal to the Earth equator toward the North pole as defined in the Earth equator, Greenwich meridian system (See ).

**SCI-15 Colatitude of Subsatellite Point at Surface at record end**

This parameter is the geodetic colatitude angle d (See ) of the subsatellite point (See ). The end of the record is 6.59 sec after the start of the record. (deg) [0 .. 180]

{Section Satellite - Celestial Data}

The geodetic colatitude is the angle between the geodetic zenith (See ) to the satellite and a vector normal to the Earth equator toward the North pole as defined in the Earth equator, Greenwich meridian system (See ).

**SCI-16 Colatitude of Subsatellite Point at Surface at record start**

See : Colatitude of Subsatellite Point at Surface at record end.

**SCI-17 Colatitude of Subsolar Point at Surface**

This parameter is the geodetic colatitude angle d (See ) of the geodetic subsolar point (See ) on the Earth surface (See ). (deg) [0 .. 180] {Section Satellite - Celestial Data}

The geodetic colatitude is the angle between the geodetic zenith (See ) to the Sun and a vector normal to the Earth equator toward the North pole as defined in the Earth equator, Greenwich meridian system (See ).

**SCI-17a Colatitude of Sublunar Point at Surface**

This parameter is the geodetic colatitude angle d (See ) of the geodetic sublunar point (See ) on the Earth surface (See ). (deg) [72 .. 119] {Section Satellite - Celestial Data}

The geodetic colatitude is the angle between the geodetic zenith (See ) to the Moon and a vector normal to the Earth equator toward the North pole as defined in the Earth equator, Greenwich meridian system (See ).

**SCI-18 Cone Angle of CERES** FOV **at Satellite**

The cone angle (See ) is the angle between a vector from the satellite to the center of the Earth and the instrument view vector from the satellite to the Earth point (See ).

(deg) [0 .. 90] {Section BDS SDS Summary}

The cone angle, along with the clock angle, (See and ) define the direction of the instrument view vector to the Earth point.



Figure ‑. Cone and Clock Angles

The toolKit call (See Reference ) PGS\_CSC\_SCtoORB transforms the instrument view vector in spacecraft coordinates to (x,y,z) orbital coordinates and the cone angle is defined by .

**SCI-19 Count Conversion SW Sample Offsets**

**SCI-20 Count Conversion TOT Sample Offsets**

**SCI-21 Count Conversion WN Sample Offsets**

These three parameters contain the detector count offsets for the SW, TOT and WN detector channels, respectively. (count) [N/A] {Section BDS SDS Summary}

Each of these offset parameters are written to the output product as a HDF Science Data Set (SDS) structure. Each structure is organized as a 4 x 660 matrix of 32-bit floating point numbers and can be depicted as 4 sets of 660 sample based offset values (See ). During processing, one or more sets of offsets are used in the count conversion process, depending on the elevation and azimuth modes of the instrument.

Offset

Offset

Offset

Offset

Offset

Offset

Offset

Offset

Offset

Offset

Offset

Offset

Offset

Offset

Offset

Offset

Offset

Offset

Offset

Offset

Offset 2

Offset 3

Offset 4

Offset 5

Offset 1

Offset

Offset

Offset

Offset

Offset 660

FAPS Normal

FAPS Short

RAPS Normal

RAPS Short

Figure ‑. SDS format for mode dependent count offsets

**SCI-22 Drift Corrected SW Counts**

**SCI-23 Drift Corrected TOT Counts**

**SCI-24 Drift Corrected WN Counts**

These parameters contains the raw count values for each detector channel, adjusted for spaceclamp, DAC update, and scan-to-scan interpolation effects. In essence, these are the resulting counts that are derived from the spaceclamp algorithm process described in Section . These count values are used for evaluating radiance count conversion gain coefficients and as data input for validation analyzes (e.g. 2nd time constant effects). (count) [N/A] {Section BDS SDS Summary}

**SCI-25 Earth-Sun Distance**

The Earth-Sun distance is the distance from the Earth’s surface to the Sun and is updated at the start of every packet. The ToolKit routine PGS\_CBP\_Earth\_CB\_Vector computes the Earth-Centered Inertial (ECI) position vector to the Sun. The ToolKit routine PGS\_CSC\_ECItoECR transforms the ECI position vector to the Earth-Centered Rotating (ECR) or Earth equator, Greenwich meridian rectangular coordinate system (See ). The Earth-Sun distance is computed from the position vector using the distance formula and then converted from meters to AU. (AU) [0.98..1.02] {Section Satellite - Celestial Data}.

**SCI-25a Earth-Moon Distance**

The Earth-Moon distance is the distance from the Earth’s surface to the Moon and is updated at the start of every packet. The ToolKit routine PGS\_CBP\_Earth\_CB\_Vector computes the Earth-Centered Inertial (ECI) position vector to the Moon. The ToolKit routine PGS\_CSC\_ECItoECR transforms the ECI position vector to the Earth-Centered Rotating (ECR) or Earth equator, Greenwich meridian rectangular coordinate system (See ). The Earth-Moon distance is computed from the position vector using the distance formula and then converted from meters to AU. (AU) [0.0024..0.0027] {Section Satellite - Celestial Data}.

**SCI-26 Julian Date and Time**

The Julian Date (or day) and Time is the time at which the CERES radiometers recorded the measurement. The Julian day changes at Greenwich noon rather than midnight (See ). The time is a fraction of a day. The ToolKit routine PGS\_TD\_SCtime\_to\_UTC converts Spacecraft time to UTC time. A second ToolKit routine, PGS\_TD\_UTCtoUTCjd, converts the ASCII string into two 64-bit real numbers. (day) {N/A] {Section BDS SDS Summary}

**SCI-27 Longitude of CERES** FOV **at Surface**

This parameter is the longitude angle  (See ) of the Earth point (See ). (deg) [0 .. 360] {Section BDS SDS Summary}

The longitude is the angle in the Earth equator plane from the Greenwich meridian (See ) to the Earth point meridian, rotating East. The geocentric longitude and geodetic longitude are the same.

**SCI-28 Longitude of CERES** FOV **at TOA**

This parameter is the longitude angle  (See ) of the TOA point (See ). (deg) [0 .. 360] {Section BDS SDS Summary}

The longitude is the angle in the Earth equator plane from the Greenwich meridian (See ) to the TOA point meridian, rotating East. The geocentric longitude and geodetic longitude are the same.

**SCI-29 Longitude of Subsatellite Point at Surface at record end**

This parameter is the longitude angle  (See ) of the subsatellite point (See ). The end of the record is 6.59 sec after the start of the record. (deg) [0 .. 360] {Section Satellite - Celestial Data}

The longitude is the angle in the Earth equator plane from the Greenwich meridian (See ) to the Earth point meridian, rotating East. The geocentric longitude and geodetic longitude are the same.

**SCI-30 Longitude of Subsatellite Point at Surface at record start**

See : Longitude of Subsatellite Point at Surface at record end

**SCI-31 Longitude of Subsolar Point at Surface**

This parameter is the longitude angle  (See ) of the geodetic subsolar point (See ) on the Earth surface (See ). (deg) [0 .. 360] {Section Satellite - Celestial Data}

The longitude is the angle in the Earth equator plane from the Greenwich meridian (See ) to the geodetic subsolar point meridian, rotating East. The geocentric longitude and geodetic longitude are the same.

**SCI-31a Longitude of Sublunar Point at Surface**

This parameter is the longitude angle  (See ) of the geodetic sublunar point (See ) on the Earth surface (See ). (deg) [0 .. 360] {Section Satellite - Celestial Data}

The longitude is the angle in the Earth equator plane from the Greenwich meridian (See ) to the geodetic sublunar point meridian, rotating East. The geocentric longitude and geodetic longitude are the same.

**SCI-31b Lunar Azimuth Angle**

This angle is measured in the X-Y plane of the spacecraft between the vector along the spacecraft –Y axis and the Moon vector projected onto the spacecraft X-Y plane. The value of the azimuth angle is zero when the two vectors are coaligned and is measured positive as a clockwise rotation of spacecraft –Y axis vector. (deg) [0 .. 360] {Section BDS SDS Summary}

**SCI-31c Lunar Elevation Angle**

This angle is measured between the Moon vector and the X-Y plane of the spacecraft. The value of the elevation angle is zero when the Moon vector is in the X-Y plane and is measured positive when the Moon is above the X-Y plane. (deg) [-90 .. 90] {Section BDS SDS Summary}

**SCI-31d Lunar Beta Angle at Record Start**

The lunar beta angle is the signed angle of the Moon vector relative to the spacecraft X-Z axis orbital plane. The signed angle is positive when the vector to the Moon is in the direction of the orbit normal. (deg) [-90 .. 90] {Section Satellite - Celestial Data}

**SCI-31e Lunar Eta Angle at Record Start**

The solar Eta angle is the signed angle of the Lunar vector projected onto the spacecraft X-Z axis orbital plane relative to the spacecraft Z-axis. (deg) [0 .. 360] {Section Satellite - Celestial Data}

**SCI-32 Primary Scan Level QA Flags**

This parameter is a 32-bit word that contains various quality assurance flags about scan level data that are used in the radiance conversion algorithm. The status word bit ordering is shown in , where zero is the least significant bit. Note: beginning with CC version 016011 BDS products, this parameter, along with the Secondary\_Scan\_Level\_QA\_Flags and Secondary\_Sample\_Level\_QA\_Flags parameters, replaces the Ancillary\_QA\_Flags\_Set\_1 and Ancillary\_QA\_Flags\_Set\_2 parameters. See and for individual flag descriptions. (none) [N/A] {Section BDS SDS Summary}

0

31

32-Bit Word

Spare

WN Heatsink Temp Edit

SW Heatsink Temp Edit

TOT Heatsink Temp Edit

WN DAC Voltage Edit

SW DAC Voltage Edit

1

2

3

4

5

6

7

8

9

10

11

12

13

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18

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21

22

23

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27

28

29

30

TOT DAC Voltage Edit

Bias Voltage Edit

Main Cover Status

MAM Cover Status

Elevation Profile ID

SW DAC Status

TOT DAC Status

WN DAC Status

DAA Ground Ref

TOT DC Status

SW DC Status

WN DC Status

Figure ‑. Primary Scan Level QA Flags

The individual flags are identified in with links to their descriptions.

Table ‑. Primary Scan Level QA Flags

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Item** | Bits | Flag Parameter Name | **Item** | Bits | Flag Parameter Name |
|  | 0 | Spares. Set to zero |  | 16 .. 16 | MAM Cover Status: |
|  | 1 | TOT DC Status: |  | 17 .. 17 | Main Cover Status:[ |
|  | 2 | SW DC Status: |  | 18 .. 19 | Bias Voltage Edit Check: |
|  | 3 | WN DC Status: |  | 20 .. 21 | TOT DAC Voltage Edit Check: |
|  | 4 .. 5 | TOT DAC Status: |  | 22 .. 23 | SW DAC Voltage Edit Check: |
|  | 6 .. 7 | SW DAC Status: |  | 24 .. 25 | WN DAC Voltage Edit Check: |
|  | 8 .. 9 | WN DAC Status: |  | 26 .. 27 | TOT Heatsink Temperature Edit Check: |
|  | 10 .. 10 | DAA Ground Reference Check: |  | 28 .. 29 | SW Heatsink Temperature Edit Check: |
|  | 11 .. 15 | Elevation Profile ID: |  | 30 .. 31 | WN Heatsink Temperature Edit Check: |

QAPSC-1 TOT/SW/WN DC Status (A scan level flag):

This flag indicates of the sensor count measurements were single or double drift corrected. Need due to very long second time constant asymptotic settling across scan boundaries. Note, these bits are utilized in BDS products with CC versions 027205 or later.

0 = Single: The scan counts were drift corrected only once.

1 = Double: The scan counts were drift corrected twice.

QAPSC-2 TOT/SW/WN DAC Status (A scan level flag):

A digital-to-analog converter (DAC) is used to digitize measurements. Due to the inherent drift of the detectors, it must shift scales to maintain the proper dynamic range of the DAC. This status represents the scaling operations performed.

00 = Good: The bridge balance controller was on and in a maintenance configuration.

01 = Updated: The bridge balance controller did an update (fine adjustment).

10 = Reset: The bridge balance controller did a reset (coarse adjustment).

11 = Off: The bridge balance controller was off.

QAPSC-3 DAA Ground Reference Check (A scan level flag):

This flag identifies that the data within the current scan may be corrupted due to the occurrence of a ground power spike. This effects the reference comparison voltage in the Analog-to-Digital converts.

0 = Good:

1 = Bad:

QAPSC-4 Elevation Profile ID (A scan level flag):

This flag identifies the actual elevation scan profile being performed for this scan. The values are used internally by the processing system. It is an index used by the radiance count conversion process for accessing the corresponding position offset table. ID values vary depending on the instrument and the variety of profile options created or selected by the science team.

QAPSC-5 MAM Cover Status (A scan level flag):

The Mirror Attenuator Mosaic (MAM) is used for solar calibrations. It has a contamination cover which is commanded open as part of initial on-orbit check-out.

0 = Opened

1 = Closed

QAPSC-6 Main Cover Status (A scan level flag):

The main contamination cover shields the radiometric detectors during launch operations. It is commanded open as part of initial on-orbit checkout.

0 = Opened

1 = Closed

QAPSC-7 Bias Voltage Edit Check (A scan level flag):

A bias voltage is converted from counts to volts and is used to compute a scan average for the radiance count conversion equations.

00 = Passed all edit checks (See Section ).

01 = Failed a high limit edit check.

10 = Failed a low limit edit check.

11 = Failed a rate edit check (measurement-to-measurement).

QAPSC-8 TOT/SW/WN DAC Voltage Edit Check (A scan level flag):

A digital-to-analog converter (DAC) voltage count value is used to compute a scan average for the radiance count conversion equations.

00 = Passed all edit checks (See Section ).

01 = Failed a high limit edit check.

10 = Failed a low limit edit check.

11 = Failed a rate edit check (measurement-to-measurement).

QAPSC-9 TOT/SW/WN Heatsink Temperature Edit Check (A scan level flag):

A converted heatsink temperature is used to compute a scan average for the radiance count conversion equations.

00 = Passed all edit checks (See Section ).

01 = Failed a high limit edit check.

10 = Failed a low limit edit check.

11 = Failed a rate edit check (measurement-to-measurement).

**SCI-33 Radiance and Mode Flags**

This parameter contains the science measurement level quality flags. It is a 32-bit word where a single bit corresponds to a particular quality assessment flag. Every measurement contained in the BDS has an associated flag. The word bit ordering is shown in , where bit zero identifies the least significant bit. The individual flags are defined in followed by their descriptions. Currently, this flag is also included in the IES, SSF, and CRS products. (none) [N/A] {Section BDS SDS Summary}

32-Bit Word

0

31

Spares

Always 0

Azimuth Motion Status

Elevation Scan Profile

Azimuth Scan Plane

TOT Filtered Radiance Flag

WN Filtered Radiance Flag

SW Filtered Radiance Flag

CERES FOV Flag

1

2

3

4

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Cone Angle Rate

Clock Angle Rate

Elevation Scan Rate

3-Channel Compare

Offset Table Index

Used in SW Spaceclamp

Used in TOT Spaceclamp

Used in WN Spaceclamp

Figure ‑. Radiance and Mode Flags

The individual flags are identified in with links to their descriptions.

Table ‑. Radiance and Mode Quality Flags Definition

| **Link** | **Bits** | Flag Parameter | **Link** | **Bits** | Flag Parameter |
| --- | --- | --- | --- | --- | --- |
|  | 0 .. 1 | CERES FOV Flag |  | 19 .. 21 | Offset Table Index |
|  | 2 .. 3 | SW Filtered Radiance Flag |  | 22 .. 23 | 3-Channel Compare |
|  | 4 .. 5 | WN Filtered Radiance Flag |  | 24 | Used in WN Spaceclamp |
|  | 6 .. 7 | TOT Filtered Radiance Flag |  | 25 | Used in TOT Spaceclamp |
|  | 8 .. 9 | Azimuth Scan Plane |  | 26 | Used in SW Spaceclamp |
|  | 10 .. 13 | Elevation Scan Profile |  | 27 | Solar Eclipse |
|  | 14 | Azimuth Motion Status |  | 28 .. 30 | Spares. Set to zero |
|  | 15 .. 16 | Elevation Scan Rate |  | 31 | N/A; Set to zero |
|  | 17 | Clock Angle Rate |  |  |  |
|  | 18 | Cone Angle Rate |  |  |  |

QA-1 CERES **FOV** Flag:

This flag is set for each CERES science measurement and is used to identify where the CERES footprint is viewing. The footprint FOV (See ) used by the geolocation calculations is based on the centroid of the detector point-spread-function, not on the optical line-of-sight. (See Reference or ). FOV calculations use the Earth surface model (WGS-84) and the CERES TOA model (30km above the WGS-84 model) provided by the ECS ToolKit.

00 = Full\_Earth\_Viewing set if

- The FOV PSF centroid pierces both the Earth surface and the TOA surface, and

- The footprint viewing area is determined to be completely on the Earth surface.

01 = Partial\_Earth set if

- The FOV PSF centroid pierces both the Earth and TOA surface, and

- The FOV footprint area includes part of the Earth’s surface (i.e., straddling the Earth limb).

10 = Hit\_TOA\_Missed\_Earth set if

- The FOV PSF centroid pierces TOA surface, but not the Earth’s surface, and

- The FOV footprint area may include part of the Earth’s surface (i.e., straddling the Earth limb).

11 = Missed TOA and Earth set if

- The FOV PSF centroid for this measurement does not pierce either the Earth’s surface or the TOA surface (e.g., the FOV is looking at a cold space above the TOA). Though the centroid does not pierce the TOA surface, the FOV footprint area may partially overlap this surface.

QA-2 SW/WN/TOT Filtered Radiance Flags:

These status flags are set for each CERES science measurement. Additional flags in the Ancillary QA Flags Set 1 (See ) provide specific information on the relevant instrument parameters.

00 = Good: All of the following conditions are met:

- All values of instrument parameters, which are used for count conversion (bias voltage, detector voltages, heatsink temperatures), passed edit limit and rate limit checks, and the overall state of the instrument is nominal for making radiometric measurements. The spaceclamp value has been computed, and passed edit and rate limit checks (See Section ).

- The instrument spurious slow mode has been corrected (See Section )

- None of the detectors were saturated at the time the measurements were taken.

- Final radiance values passed edit checks (See Section ).

- There were no computational or numerical errors resulting from the count conversion process.

01 = Eclipse: This measurement is good. However, this measurement was geolocated in the shadow of a solar eclipse event. (See )

10 = Bad: Failed one or more of the above conditions. The CERES default fill value is output instead of the actual computed radiance value (See ).

11 = Reserved - Not used.

QA-3 Azimuth Scan Plane:

This flag is derived from scan level information and is used to define the azimuth gimbal scan plane for each measurement (See ). Individual bit patterns are defined as follows:

00 = Crosstrack set if

- This flag is set when the azimuth gimbal is in a fixed position with the elevation scanning plane within 45 degrees of the normal to the spacecraft velocity vector. Typically, this means the gimbal is at the 180 (or 0) degree azimuth position as defined by the instrument coordinate system. This azimuth position allows the elevation scan to sweep across the ground track in a side-to-side motion. This scan plane flag is a special case of the FAPS.

01 = RAPS (Biaxial) set if

- This flag is set when the azimuth gimbal is rotating between two defined azimuth end points for the measurement.

10 = FAPS set if

- This flag is set when the azimuth gimbal is in a fixed position at any position other than crosstrack for the measurement. For example, the instrument may be in the along-track scan plane where the elevation scan plane is oriented parallel to the spacecraft velocity vector (e.g., the azimuth position = 90 or 270 degrees).

11 = Transitional set if

- Defined as anything not covered above. Typically, this flag is set when the instrument is changing between the crosstrack and biaxial modes while the elevation gimbal is stowed.

QA-4 Elevation Scan Profile:

This flag is derived from scan level information that is duplicated for each measurement within the entire packet. Individual bit patterns are defined as follows:

0000 = Normal-Earth Scan (See )

0001 = Short-Earth Scan (See )

0010 = MAM Scan (See and )

0011 = Nadir Scan (See )

0100 = Stowed Profile (See )

0101 = Other Profile (Anything not classified above.)

QA-5 Azimuth Motion Status:

This flag is derived from scan level information that is duplicated for each measurement. Individual bit patterns are defined as follows:

0 = Fixed: The azimuth gimbal is stopped at a fixed position for the entire packet.

1 = In Motion: The azimuth gimbal is moving during all or part of the packet. Motions can include biaxial scans or transitions between azimuth modes.

QA-6 Elevation Scan Rate:

This flag is used to identify the elevation gimbal scan rate for the current measurement. The scan rate is derived by taking the absolute value of the elevation gimbal position difference in degrees between the current and previous measurements, and dividing by the sample time interval (0.01 seconds) to obtain a two point instantaneous scan rate (See ). The scan rate for the current sample is then categorized according to the following flag definitions.

00 = Nominal:

- The elevation gimbal for this measurement is moving at a nominal rate of 63.14 +/-2.5 deg/sec.

01 = Fast:

- The elevation gimbal is moving faster than 63.14 +2.5 deg/sec for this measurement. Typically, this condition occurs when the gimbal is in the fast retrace portion of the short-earth scan profile or when slewing to the internal calibration position. (Retrace rate is currently defined as 249.69 +/-10 deg/sec.) However, during scan inflection points (when the gimbal changes motion speed or direction) normal servomechanical ringing can occur which could indicate fast rates while the gimbal settles out (which can take up to ten samples).

10 = Slow/Stopped:

- The elevation gimbal is not moving or is moving at a slow rate (i.e., < 63.14 -2.5 deg/sec) for this measurement. Slow rates are usually identified when the gimbal is ramping up to speed from a stopped position (e.g., from spacelook position). Due to the backward two point scan rate algorithm, the first sample in a scan will be set to stopped since there are no profiles that have the elevation moving at the very beginning of a scan.

11 = Other:

- The elevation gimbal scan rate could not be classified into one of the above categories for this measurement. This would be typical of measurements during gimbal transitions between stop and go conditions.)

QA-7 Clock Angle Rate/Cone Angle Rate:

These flags are used to indicate whether an angular rate could be computed from valid angles. No edit checks are performed. (See and )

0 = Good: The angular rate for this measurement is computed from valid angles for current and previous measurements.

1 = Bad: The angular rate for this measurement could not be computed. Consequently, the CERES default fill value is output to the BDS rate field.

QA-8 Offset Table Index:

These flags are used to index (0..7) the offsets values contained within the scan Offset Table used in the radiance count conversion. (Need table reference?)

QA-9 3-Channel Compare Results:

These flags are used to indicate a comparison results between the three radiometric channels. Used to identify possible electronic glitches.

00 = Passed:

- All three channels are good.

01 = Bit Flip:

- The comparison analysis indicated one or more channel had a possible erroneous digital bit flip.

10 = Sun Glint:

- The comparison analysis indicated the radiances values may be seeing Sun Glint conditions.

11 = Error:

- The comparison analysis could not determine reason for faulty values.

QA-10 TOT/SW/WN Measurement used In SpaceClamp Algorithm:

A flag indicating whether the detector count value for this measurement was used in computing a   
spaceclamp average value for the count conversion algorithm.

0 = False: The detector count values for this measurement were not used.

1 = True: The detector count values for this measurement were used.

QA-11 Solar Eclipse Measurement:

A flag indicates if this radiance measurement was in the shadow of a solar eclipse. (See )

0 = False: This measurement is not in the shadow of a solar eclipse.

1 = True: This measurement was geolocated under the shadow of a solar eclipse.

**SCI-34 Rate of Change of Clock Angle**

This parameter is the angular velocity of the clock angle (See ). (deg sec-1) [-10 .. 10] {Section BDS SDS Summary}

The nominal RAPS configuration begins with the azimuth scan plane in the along-track orientation and rotates through 180o of clock angle until the scan plane is again in the along-track orientation. The process is then reversed. However, when the Sun is close to the orbital plane (low beta angles), the RAPS configuration begins with the scan plane rotated 20o (TRMM) or 7o (Terra/Aqua) from the along-track orientation and rotates through 140o (TRMM) or 166o (Terra/Aqua) of clock angle until the scan plane is again 20o (TRMM) or 7o (Terra/Aqua) from the along-track orientation. This process is then reversed. The clock rate is not measured, but is approximated with two consecutive clock angle positions.

The magnitude value of the clock rate is nominally 6.042 ± 1.098 deg/sec. The clock rate is negative when the azimuth angle is decreasing, positive when the azimuth angle is increasing, and zero when the clock angle is constant. However, when the azimuth changes direction, the magnitude of the clock rate will approach 0 deg/sec and then increase to almost 14 deg/sec

before settling back to the nominal magnitude. When the instrument is operating in the FAPS mode, the clock rate is set to zero. This is the nominal S-NPP instrument operations.

**SCI-35 Rate of Change of Cone Angle**

This parameter is the angular velocity of the cone angle (See ). (deg sec-1) [-100 .. 100] {Section BDS SDS Summary

The cone rate is negative when scanning toward nadir, positive when scanning away from nadir, and zero when the cone angle is constant. The cone rate is not measured, but is approximated with two consecutive cone angle positions. The nominal cone rate isapproximately ±63 deg/sec.

**SCI-36 Sample Aligned Analog Data**

This parameter contains a copy of the level 0 analog engineering count values for all 660 measurements per scan. (count) [N/A] {Section BDS SDS Summary}

**SCI-37 Satellite Position at record end**

**SCI-38 Satellite Position at record start**

These parameters indicate the X, Y, and Z components of the satellite inertial position at the satellite nadir point corresponding to the first or last measurement in the packet. (km) [-8000 ..8000] {Section Satellite - Celestial Data}

The positions are referenced to the Earth-Centered Rotating (ECR) coordinate system. The ToolKit routine, PGS\_EPH\_EphemAttit, computes the satellite position vector in Earth-Centered Inertial (ECI) coordinates. A second ToolKit routine, PGS\_CSC\_ECItoECR, transforms the position vector to the ECR or Earth equator, Greenwich meridian rectangular coordinate system (See ). Meters are then converted to kilometers.

**SCI-39 Satellite Velocity at record end**

**SCI-40 Satellite Velocity at record start**

These parameters indicate the X, Y, and Z components of the satellite inertial velocity at the satellite nadir point corresponding to the first or last measurement in the packet. (km sec-1) [-10 ..10] {Section Satellite - Celestial Data}

The positions are referenced to the Earth-Centered Rotating (ECR) coordinate system. The ToolKit routine, PGS\_EPH\_EphemAttit, computes the satellite velocity vector in Earth-Centered Inertial (ECI) coordinates. A second ToolKit routine, PGS\_CSC\_ECItoECR, transforms the velocity vector to the ECR or Earth equator, Greenwich meridian rectangular coordinate system (See ). Meters/second are then converted to kilometers/second.

**SCI-41 Secondary Sample Level QA Flags**

This parameter is a 16-bit word that contains various quality assurance flags about measurement level data that are used in the radiance conversion algorithm. The status word bit ordering is shown in , where zero is the least significant bit. Note: beginning with CC version 016011 BDS products, this parameter, along with the Primary\_Scan\_Level\_QA\_Flags and Secondary\_Scan\_Level\_QA\_Flags parameters, replaces the Ancillary\_QA\_Flags\_Set\_1 and Ancillary\_QA\_Flags\_Set\_2 parameters. See and for individual flag descriptions.

(none) [N/A] {Section BDS SDS Summary}

16-Bit Word

Spare

SW 2nd TC Vk Status

TOT 2nd TC Vk Status

WN 2nd TC Vk Status

WN Radiance Edit

SW Radiance Edit

TOT Radiance Edit

0

1

2

3

4

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14

15

Figure ‑. Secondary Sample Level OA Flags

The individual flags are identified in with links to their descriptions.

Table ‑. Secondary Sample Level QA Flags

| Item | Bits | Flag Parameter |
| --- | --- | --- |
|  | 0 .. 2 | TOT 2nd Time Constant Vk Status: |
|  | 3 .. 5 | SW 2nd Time Constant Vk Status: |
|  | 6 .. 8 | WN 2nd Time Constant Vk Status: |
|  | 9 | Spare |
|  | 10 .. 11 | TOT Radiance Edit Check: |
|  | 12 .. 13 | SW Radiance Edit Check: |
|  | 14 .. 15 | WN Radiance Edit Check: |

QASSA-1 TOT/SW/WN 2nd Time Constant Vk Status (A measurement level flag):

A flag indicating how the spurious transient compensation function (i.e., the 2nd time constant numerical equation) was used to adjust the radiance measurement. See Section for additional information.

000 = Off: The measurement did not use the spurious transient compensation function.

001 = Used\_Previous: The measurement used a Vk term in the spurious transient compensation function that was derived from the previous measurement Vk term.

010 = Recalculated: The measurement used a substituted, calculated Vk term in the spurious transient compensation function that was not derived from the previous measurement Vk term due to a time gap or a bad radiance value.

QASSA-2 TOT/SW/WN Radiance Edit Check (A measurement level flag):

A flag to indicate the status of various edit checks applied to the raw counts and the converted filtered radiances. Note: beginning with CC version 027025 BDS products, the bit configuration has been changed.

Pre-CC 027025 versions:

000 = Passed all edit checks (See Section ).

001 = Failed a high limit edit check.

010 = Failed a low limit edit check.

011 = Failed a rate edit check (measurement-to-measurement).

100 = Converted Radiance was a Fill Value.

101 = Converted Radiance Saturated High.

Post-CC 027025 versions:

000 = Within Limits (See Section ).

001 = Exceeds Low. The converted radiance value is less than the lower edit limit.

010 = Crosstalk Detected. The counts were corrupted by inter-channel crosstalk noise.

011 = Saturated Primary. The raw count had a saturated value of 4095, the converted radiance is set to fill-value.

100 = Saturated Secondary. The raw count did not saturate, however, one of the other sensor channels was saturated, the converted radiance is set to fill-value.

101 = Saturated Sun Glint. The raw count were saturated due to a Sun Glint,, the converted radiance is set to fill-value.

111 = Zeroed Count. The raw count had a zero value, the converted radiance is set to fill-value.

Others = Reserved for future use.

**SCI-42 Secondary Scan Level QA Flags**

This parameter is a 16-bit word that contains various quality assurance flags about scan level data that are used in the radiance conversion algorithm. The status word bit ordering is shown in , where zero is the least significant bit. Note: beginning with CC version 016011 BDS products, this parameter, along with the Primary\_Scan\_Level\_QA\_Flags and Secondary\_Sample\_Level\_QA\_Flags parameters, replaces the Ancillary\_QA\_Flags\_Set\_1 and Ancillary\_QA\_Flags\_Set\_2 parameters. See and for individual flag descriptions. (none) [N/A] {Section BDS SDS Summary}

16-Bit Word

0

1

2

3

4

5

6

7

8

9

10

11

12

13

14

15

WN Space Clamp

SW Space Clamp

TOT Space Clamp

Spare

Solar Heating

Figure ‑. Secondary Scan Level QA Flag

The individual flags are identified in with links to their descriptions.

Table ‑. Secondary Scan Level QA Flags

|  |  |  |
| --- | --- | --- |
| Item | Bits | Flag Parameter Name |
|  | 0 .. 2 | Spares. Set to zero |
|  | 3 | Solar Heating Status: |
|  | 4 .. 7 | TOT SpaceClamp Status: |
|  | 8 .. 11 | SW SpaceClamp Status: |
|  | 12 .. 15 | WN SpaceClamp Status: |

QASSC-1 TOT/SW/WN SpaceClamp Status (A scan level flag):

A flag indicating the edit check status of the computed spaceclamp value used in this radiance   
measurement computation.

0000 = Good: Passed all edit and algorithm tests (See Section ).

0001 = Limit\_Error: Outside statistical edit limits.

0010 = Too\_Few\_Samples: To compute a space clamp.

0011 = No\_2nd\_Value: (i.e., the spaceclamp from the current scan was duplicated).

0100 = DAC\_Reset occurred.

0101 = Unrecoverable\_DAC\_Update (i.e., could not adjust for the update).

0110 = Adjust\_DAC\_Update.

0111 = Invalid\_Zero\_Reference.

1000 = Moon\_In\_FOV (Verified by ToolKit celestial calculations)

1001 = Moon\_Check\_Error.

1011 = DAC\_SetPoint\_Changed.

1111 = Unknown Error.

Others = Reserved for future use.

QASSC-1a Solar Heating Status (A scan level flag):

A flag indicating the edit check status of the computed spaceclamp value used in this radiance   
measurement computation.

0 = No\_Heating: The Sun is not within the bolomter filter FOV limit threshold .

1 = Heating: The Sun is impinging on the bolometer filter FOV perimeter.

**SCI-42a Solar Beta Angle at Record Start**

The solar beta angle is the signed angle of the Sun vector relative to the spacecraft X-Z axis orbital plane. The signed angle is positive when the vector to the Sun is in the direction of the orbit normal. (deg) [-90 .. 90] {Section Satellite - Celestial Data}

**SCI-42b Solar Eta Angle at Record Start**

The solar Eta angle is the signed angle of the Sun vector projected onto the spacecraft X-Z axis orbital plane relative to the spacecraft Z-axis. (deg) [0 .. 360] {Section Satellite - Celestial Data}

**SCI-42c Solar Azimuth Angle**

This angle is measured in the X-Y plane of the spacecraft between the vector along the spacecraft –Y axis and the Sun vector projected onto the spacecraft X-Y plane. The value of the azimuth angle is zero when the two vectors are coaligned and is measured positive as a clockwise rotation of spacecraft –Y axis vector. (deg) [0 .. 360] {Section BDS SDS Summary}

**SCI-42d Solar Elevation Angle**

This angle is measured between the Sun vector and the X-Y plane of the spacecraft. The value of the elevation angle is zero when the Sun vector is in the X-Y plane and is measured positive when the Sun is above the X-Y plane. (deg) [-90 .. 90] {Section BDS SDS Summary}

**SCI-42e Solar Calibration MAM FOV Azimuth Angle**

This angle represents the Sun azimuth position with respect to the MAM telescope optical axis during solar calibration operations. The FOV of the MAM in azimuth is nominally +/-5°. The basic equation is Converted Azimuth angle – Solar Azimuth Angle. (deg) [-15 .. 15] {Section BDS SDS Summary}

**SCI-42f Solar Calibration MAM FOV Elevation Angle**

This angle represents the Sun elevation position with respect to the MAM telescope optical axis during solar calibration operations. The FOV of the MAM in elevation is nominally +/-5°. The basic equation is Converted Elevation angle + Solar Elevation Angle. (deg) [-15 .. 15] {Section BDS SDS Summary}

**SCI-43 SW Channel Spurious Slow Mode Constants**

**SCI-44 TOT Channel Spurious Slow Mode Constants**

**SCI-45 WN Channel Spurious Slow Mode Constants**

These constants,  and c, are used in the radiometric count conversion calculation to correct the spurious slow mode effect for each detector channel. See Section for additional information and : on Slow Mode algorithm for further details. (sec-1; c: none) [N/A] {Section Count Conversion Constants

**SCI-46 SW Channel Gain Constants**

**SCI-47 TOT Channel Gain Constants**

**SCI-48 WN Channel Gain Constants**

Constants, represented as AV, AVA, AHA, AD, AB, and C, are used to determine the radiometric count conversion gain coefficients for each detector channel. Refer to (Reference for additional information. (AHA: count2 (K volt)-1; others: count volt-1) [N/A] {Section Count Conversion Constants}

**SCI-49 SW Radiance Edit Limits**

**SCI-50 TOT Radiance Edit Limits**

**SCI-51 WN Radiance Edit Limits**

These values represent the minimum and maximum allowable radiance values for each detector channel. (Wm-2 sr-1) [N/A] {Section Count Conversion Constants}

**SCI-52 SW Spaceclamp Values**

**SCI-53 TOT Spaceclamp Values**

**SCI-54 WN Spaceclamp Values**

These parameters contain averaged spacelook values for each detector channel. These spacelook averages are required for the radiometric count conversion of individual detector measurements. Refer to Section for a more detailed explanation of spacelook averages and the spaceclamp algorithm. Each of these spaceclamp parameters are written to the output product as a HDF SDS structure. Each structure is organized as a n x 2 matrix of 32-bit floating point numbers, where n = number of packets processed in the BDS, nominally = 13091. For a given packet or row index in each SDS, column 1 contains the spacelook average for that packet and column 2 contains the spacelook average for the next or subsequent packet. (See ).

|  |  |  |
| --- | --- | --- |
|  | Column 1 | Column 2 |
| Packet n |  |  |
| Packet n + 1 |  |  |
| Packet n + 2 |  |  |

Figure ‑. Spacelook Average SDS Format

Under nominal conditions, . In cases where a spacelook average could not be calculated, the CERES default fill value will be used. Additional information about the spacelook averages can be found in the ancillary QA flags set 2 (See ). (count) [N/A] {Section Count Conversion Constants}

**SCI-55 SW Slow Mode and Drift Corrected Counts**

**SCI-56 TOT Slow Mode and Drift Corrected Counts**

**SCI-57 WN Slow Mode and Drift Corrected Counts**

These parameters contains the initial drift corrected count values for each detector channel, readjusted a second time for spaceclamp, DAC update, and scan-to-scan interpolation effects. These count values are used for evaluating the final radiance count conversion gain coefficients and as data input for validation analyzes (e.g. 2nd time constant effects). These data are only available in data products beginning with Aqua and Terra Edition1 BDSs beginning with CC-Code 027025 and Aqua and Terra Edition2 BDSs beginning with CC-Code 028028.

(count) [N/A] {Section BDS SDS Summary}

#### Instrument Parameter Descriptions

Instrument parameter value ranges or default values referenced throughout this document are typically based on the actual on-board instrument flight software. However, values may differ between this document and referenced documents. Future updates to this document will attempt to capture the as-flown instrument values. Many of the descriptions in this section will apply to both raw and converted values. Therefore, the units, ranges, and structure hyperlink reference sections are given for both values and ordered by raw followed by the converted entries. An alphabetical listing of the instrument parameters is shown in .

**INS-1 ACA Electronics Temperature**

This parameter measures the temperature of the azimuth control assembly electronics. The converted value is computed using DRL-64 Algorithm C. For the exact location of this sensor, see DRL-64 (Reference ). (Count, oC) [0 .. 4095, -30 .. 70] {Section Temperature Counts, Section Converted Temperatures}

**INS-2 ACA Torque Output**

This parameter measures the azimuth gimbal torque that is converted to a servo controller signal. The converted values are computed using DRL-64 (Reference ) Linear Coefficients Algorithm listed in . (Count, in-oz) [0 .. 4095, -20 .. 20] {Section Voltage - Torque Counts, Section Converted Voltages and Torques}

**INS-3 Azimuth Defined Asynchronous Scan Rate**

This parameter indicates the azimuth gimbal asynchronous slew rate for the nominal Biaxial science mode. An Asynchronous slew is defined as scanning between two defined azimuth positions with no time synchronization to the scan boundaries. (Refer to for example slewing pattern.) The default value is approximately 5 degrees/second for PFM, FM 1, and FM 2, but is expected be changed with the Set\_Azimuth\_Rate\_Async\_Rate command is set to 6 degrees/second immediately following any instrument power-ups or resets. For FM 3 and FM 4, the default rate is already set to approximately 6 degrees/second. The converted value is computed using DRL-64 (Reference ) Algorithm (deg sec-1) [4 .. 6] {Section Converted Instrument Status Data}

**INS-4 Azimuth Defined Crosstrack Position**

This parameter indicates the azimuth gimbal fixed position setpoint. Its default value corresponds to 180 degrees. The converted value is computed using DRL-64 (Reference ) Algorithm Linear Coefficients listed in . (For FM 1/2, see also bias correction note.) This default value can be changed with the Set\_Azimuth\_Fixed\_Crosstrack command. (deg) [0 .. 360] {Section Converted Instrument Status Data}

**INS-5 Azimuth Defined Fixed Cage Position**

This parameter indicates the azimuth gimbal fixed position setpoint. Its default value corresponds to 0.1 degrees. The converted value are computed using DRL-64 (Reference ) Algorithm Linear Coefficients listed in . (For FM 1/2, see also bias correction note.) The default values can be changed with the Set\_Azimuth\_Fixed\_Caged command.

(deg) [0 .. 360] {Section Converted Instrument Status Data}

**INS-6 Azimuth Defined Fixed Position A**

**INS-7 Azimuth Defined Fixed Position B**

These parameters indicate the azimuth gimbal fixed position setpoint that defines the bounds for a rotating azimuth scanning (biaxial) operation. Position A represents the starting point and Position B represents the ending point for a rotating scan. However, during solar avoidance operations involving low solar Beta angles, these values will be changed by the Set\_Azimuth\_Fixed\_Position\_A and the Set\_Azimuth\_Fixed\_Position\_B commands for a solar avoidance scan profile. See for expected values for each instrument. The converted values are computed using DRL-64 (Reference ) Algorithm Linear Coefficients listed in . (For FM 1/2, see also bias correction note.) (deg) [0 .. 360] {Section Converted Instrument Status Data}

Table ‑. Azimuth Default Normal and Solar Avoidance A/B Angles (Deg.)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Instrument | Position Angle A | | Position Angle B | |
| Normal | Solar Avoidance | Normal | Solar Avoidance |
| PFM | 90 | 110 | 270 | 250 |
| FM 1, FM 2 | 90 | 97 (94) | 270 | 263 (266) |
| FM 3, FM 4 | 90 | 94 | 270 | 266 |
| FM 5 | 90 | 97 | 270 | 263 |

**INS-8 Azimuth Defined Fixed Position Spare 1**

**INS-9 Azimuth Defined Fixed Position Spare 2**

**INS-10 Azimuth Defined Fixed Position Spare 3**

These parameters indicate the azimuth gimbal fixed position setpoints. The converted values are computed using DRL-64 (Reference ) Algorithm Linear Coefficients listed in . (For FM 1/2, see also bias correction note.) The fixed position spare 2 value is typically used for contamination safing operations. The default values can be changed with the commands shown below.

* **Fixed Position Spare 1** Default = 45 deg Set\_Azimuth\_Fixed\_Spare\_1
* **Fixed Position Spare 2** Default = 165 deg Set\_Azimuth\_Fixed\_Spare\_2
* **Fixed Position Spare 3** Default = 329 deg Set\_Azimuth\_Fixed\_Spare\_3

(deg) [0 .. 360] {Section Converted Instrument Status Data}

**INS-11 Azimuth Defined Fixed Solar Calibration Position**

This parameter indicates the azimuth gimbal fixed position setpoint. Its default value corresponds to 105 degrees. This position is used to orient the instrument so that the MAM aperture opening will face the Sun during a solar calibration event. This default value is expected to be changed with the Set\_Azimuth\_Fixed\_Solarcal command to 180 degrees immediately following any instrument power-ups or resets. During normal mission operation solar calibrations, this fixed azimuth position will be changed to point the instrument MAM port in the direction of the solar azimuth position that is derived from orbital planning aids. The converted value is computed using DRL-64 (Reference ) Algorithm Linear Coefficients listed in . (See also bias correction note.) (deg) [0 .. 360] {Section Converted Instrument Status Data}

**INS-12 Azimuth Defined Normal Slew Rate**

This parameter indicates the azimuth gimbal slewing rate for motions typically involving Goto\_Position\_X operations. Its default value corresponds to approximately 6 degrees/second. The converted value is computed using DRL-64 (Reference ) Algorithm. This default value can be changed with the Set\_Azimuth\_Rate\_Goto\_Rate command. (deg sec-1) [4 .. 6] {Section Converted Instrument Status Data}

**INS-13 Azimuth Defined Synchronous Scan Rate**

This parameter indicates the azimuth gimbal synchronously slew rate for an optional Biaxial science mode. A Synchronous slew is defined as scanning between two points where upon reaching an end point, the azimuth will hold that position until the beginning of the next scan start. (Refer to for example slewing pattern.) Its default value corresponds to approximately 4 degrees/second. The converted value is computed using DRL-64 (Reference ) Algorithm. This default value can be changed with the Set\_Azimuth\_Rate\_Sync\_Rate command. (deg sec-1) [4 .. 6] {Section Converted Instrument Status Data}

**INS-14 Azimuth Error**

This parameter measures converted azimuth gimbal error position values that are measured for each sample 0 .. 659. These data are output to a BDSG product when the instrument is in the diagnostic gimbal error configuration. The converted value is computed using DRL-64 (Reference ) Algorithm Linear Coefficients listed in . (deg) [0 .. 360] {Section BDS SDS Summary}

**INS-15 Azimuth Lower Bearing Temperature**

This parameter measures the temperature of the lower azimuth gimbal bearing assembly, used to monitor friction buildup. The converted value is computed using DRL-64 Algorithm C. For the exact location of this sensor, see DRL-64 (Reference ). (Count, oC) [0 .. 4095, -30 .. 70] {Section Temperature Counts, Section Converted Temperatures}

**INS-16 Azimuth Offset Correction**

This parameter indicates an internal count adjustment to compensate for the encoder position to actual gimbal position misalignment. The converted value is computed using DRL-64 (Reference ) Algorithm Linear Coefficients listed in . This value will reflect the internal default value or the last update by the Set\_Azimuth\_Offset\_Correction command. This value needs to be treated as a signed integer data representation. The nominal unsigned and signed integer values are shown in below. (deg) [0 .. 360] {Section Converted Instrument Status Data}

Table ‑. Azimuth Offset Correction Nominal Values (counts)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| TRMM | Terra | | Aqua | | S-NPP |
| PFM | FM 1 | FM 2 | FM 3 | FM 4 | FM 5 |
| 65394 (-141) | 162 | 137 | N/A | 65282 (-253) | 65523 (-13) |

**INS-17 Azimuth Position Error**

This parameter indicates the gimbal controller error (commanded versus actual difference) corresponding to sample 351 (out of 0 .. 659). This value is also copied to the operational housekeeping packet. When the azimuth brake is applied, the azimuth gimbal will physically move approximately 0.5 degrees, which will be reflected in this error value. This value needs to be treated as a signed integer data representation. (deg) [0 .. 360] {Section Converted Instrument Status Data}

**INS-18 Azimuth Upper Bearing Temperature**

This parameter measures the temperature for the upper azimuth gimbal bearing assembly used to monitor friction buildup. The converted value is computed using DRL-64 Algorithm C. For the exact location of this sensor, see DRL-64 (Reference ). (Count, oC) [0 .. 4095, -30 .. 70] {Section Temperature Counts, Section Converted Temperatures}

**INS-19 Converted Azimuth Angles**

This parameter indicates the converted azimuth gimbal position. illustrates the default synchronous and asynchronous profiles. For solar and lunar calibrations that require a raster scan operations, an A-only synchronous profile has been added post-launch (See ). The converted values are computed using DRL-64 (Reference ) Linear Coefficients Algorithm listed in . (For FM 1/2, see also bias correction note.) (deg) [0 .. 360] {Section Converted Instrument Status Data}

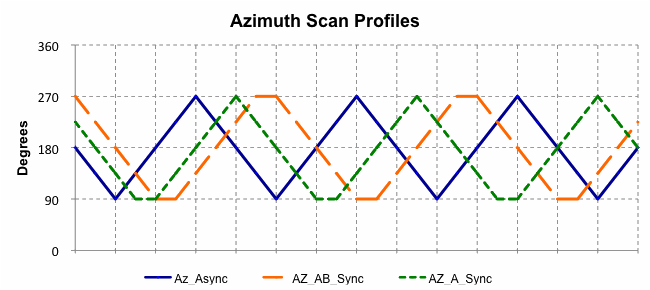


Figure ‑. Azimuth Scan Profiles

**INS-20 Converted Elevation Angles**

This parameter indicates the converted elevation gimbal positions. (deg) [0 .. 260] {Section Converted Instrument Status Data}

See for a sketch of the nominal science related CERES scan elevation profiles and , , , , , and that details these profiles. The tables identify the type of scan profile (e.g., normal-earth scan) along with the corresponding sample numbers and angular position ranges. Note that an alternate MAM scan profile is being adopted that only does a single MAM stare and a single ICS stare per scan. For targeted overflight and inter-satellite comparison, nadir viewing profiles have been adopted. A modified short-earth scan profile has also been adopted.

The converted values are computed using DRL-64 (Reference ) Linear Coefficients Algorithm listed in . No adjustment for PSF lag or any other instrument or science factors have been made to these values. See Section for a discussion on the PSF lag algorithm.









Figure ‑. Elevation Scan Profiles

The following tables show the sample numbers and the elevation angular position ranges for the different FOV looks for the five commonly used scan profiles. There is no diagram for the stowed elevation profile as there is only one elevation angle (260o) for the entire profile (See ).

Table ‑. Normal Earth Scan Elevation Profile

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| FOV Look | TRMM | | Terra/Aqua | | S-NPP | |
| Sample # | Angle (Deg.) | Sample # | Angle (Deg.) | Sample # | Angle (Deg.) |
| Space look | 0 .. 39 | 11 | 0 .. 49 | 18 | 0 .. 52 | 20 |
| Earth scan | 40 .. 290 | 11 .. 169 | 50 .. 278 | 18 .. 162 | 53 .. 275 | 20 .. 160 |
| Space look | 291 .. 311 | 169 | 279 .. 304 | 162 | 276 .. 302 | 160 |
| Housing look | 312 .. 319 | 169 .. 194 | 305 .. 316 | 162 .. 194 | 303 .. 315 | 160 .. 194 |
| Internal Cal | 320 .. 340 | 194 | 317 .. 341 | 194 | 316 .. 342 | 194 |
| Housing look | 341 .. 348 | 194 .. 169 | 342 .. 353 | 194 .. 162 | 343 .. 355 | 194 .. 160 |
| Space look | 349 .. 369 | 169 | 354 .. 379 | 162 | 356 .. 382 | 160 |
| Earth scan | 370 .. 620 | 169 .. 11 | 380 .. 608 | 162 .. 18 | 383 .. 605 | 160 .. 20 |
| Space look | 621 .. 659 | 11 | 609 .. 659 | 18 | 606 .. 659 | 20 |

Table ‑. Short Earth Scan Elevation Profile

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| FOV Look | TRMM | | Terra/Aqua | | S-NPP | |
| Sample # | Angle (Deg.) | Sample # | Angle (Deg.) | Sample # | Angle (Deg.) |
| Space look | 0 .. 38 | 11 | 0 .. 49 | 18 | 0 .. 52 | 20 |
| Earth scan | 39 .. 253 | 11 .. 145 | 50 .. 241 | 18 .. 138 | 53 .. 224 | 20 .. 128 |
| Earth Dwell | --- | --- | --- | --- | 225 .. 245 | 128 |
| Fast retrace | 254 .. 307 | 145 .. 11 | 242 .. 289 | 138 .. 18 | 246 .. 288 | 128 .. 20 |
| Space look | 308 .. 351 | 11 | 290 .. 368 | 18 | 289 .. 370 | 20 |
| Earth scan | 352 .. 566 | 11 .. 145 | 369 .. 560 | 18 .. 138 | 371 .. 541 | 20 .. 128 |
| Earth Dwell | --- | --- | --- | --- | 542 .. 563 | 128 |
| Fast retrace | 567 .. 620 | 145 .. 11 | 561 .. 608 | 138 .. 18 | 564 .. 606 | 128 .. 20 |
| Space look | 621 .. 659 | 11 | 609 .. 659 | 18 | 607 .. 659 | 20 |

Table ‑. MAM Scan (Solar Calibration) Elevation Profile

| FOV Look | TRMM | | Terra/Aqua | | S-NPP |
| --- | --- | --- | --- | --- | --- |
| Sample # | Angle (Deg.) | Sample # | Angle (Deg.) | (N/A) |
| Space look | 0 .. 51 | 169 | 0 .. 48 | 162 |  |
| Housing look | 52 .. 78 | 169 .. 236 | 49 .. 78 | 162 .. 236 |  |
| MAM | 79 .. 129 | 236 | 79 .. 129 | 236 |  |
| Housing look | 130 .. 156 | 236 .. 169 | 128 .. 157 | 236 .. 162 |  |
| Space look | 157 .. 208 | 169 | 158 .. 208 | 162 |  |
| Housing look | 209 .. 217 | 169 .. 194 | 207 .. 219 | 162 .. 194 |  |
| Internal Cal | 218 .. 269 | 194 | 220 .. 268 | 194 |  |
| Housing look | 269 .. 277 | 194 .. 169 | 269 .. 281 | 194 .. 162 |  |
| Space look | 278 .. 381 | 169 | 282 .. 377 | 162 |  |
| Housing look | 382 .. 408 | 169 .. 236 | 378 .. 407 | 162 .. 236 |  |
| MAM | 409 .. 459 | 236 | 408 .. 456 | 236 |  |
| Housing look | 460 .. 486 | 236 .. 169 | 457 .. 486 | 236 .. 162 |  |
| Space look | 487 .. 538 | 169 | 487 .. 535 | 162 |  |
| Housing look | 539 .. 547 | 169 .. 194 | 536 .. 548 | 162 .. 194 |  |
| Internal Cal | 548 .. 598 | 194 | 549 .. 597 | 194 |  |
| Housing look | 599 .. 607 | 194 .. 169 | 598 .. 610 | 194 .. 162 |  |
| Space look | 608 .. 659 | 169 | 611 .. 659 | 162 |  |

Table ‑. Alternate MAM Scan (Solar Calibration) Elevation Profile

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| FOV Look | TRMM | | Terra/Aqua | | S-NPP | |
| Sample # | Angle (Deg.) | Sample # | Angle (Deg.) | Sample # | Angle (Deg.) |
| Space look | 0 .. 48 | 169 | 0 .. 48 | 162 | 0 .. 48 | 160 |
| Housing look | 49 .. 75 | 169 .. 236 | 49 .. 78 | 162 .. 236 | 49 .. 78 | 160 .. 236 |
| MAM | 76 .. 274 | 236 | 79 .. 274 | 236 | 79 .. 274 | 236 |
| Housing look | 275 .. 301 | 236 .. 169 | 275 .. 304 | 236 .. 162 | 275 .. 304 | 236 .. 160 |
| Space look | 302 .. 354 | 169 | 305 .. 354 | 162 | 305 .. 353 | 160 |
| Housing look | 355 .. 364 | 169 .. 194 | 355 .. 367 | 162 .. 194 | 354 .. 367 | 160 .. 194 |
| Internal Cal | 365 .. 596 | 194 | 368 .. 596 | 194 | 368 .. 597 | 194 |
| Housing look | 597 .. 606 | 194 .. 169 | 597 .. 609 | 194 .. 162 | 598 .. 610 | 194 .. 160 |
| Space look | 607.. 659 | 169 | 610 .. 659 | 162 | 611 .. 659 | 160 |

Table ‑. Nadir Earth Scan Elevation Profile

| FOV Look | TRMM | | Terra/Aqua | | S-NPP | |
| --- | --- | --- | --- | --- | --- | --- |
| Sample # | Angle (Deg.) | Sample # | Angle (Deg.) | Sample # | Angle (Deg.) |
| Space look | 0 .. 38 | 11 | 0 .. 49 | 18 | 0 .. 52 | 20 |
| Earth scan | 39 .. 164 | 11 .. 90 | 50 .. 163 | 18 .. 90 | 53 .. 163 | 20 .. 90 |
| Nadir stare | 165 .. 494 | 90 | 164 .. 494 | 90 | 164 .. 494 | 90 |
| Earth scan | 495 .. 620 | 90 .. 11 | 495 .. 608 | 90 .. 18 | 495 .. 605 | 90 .. 20 |
| Space look | 621 .. 659 | 11 | 609 .. 659 | 18 | 606 .. 659 | 20 |

Table ‑. Stowed Elevation Profile

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| FOV Look | TRMM | | Terra/Aqua | | S-NPP | |
| Sample # | Angle (Deg.) | Sample # | Angle (Deg.) | Sample # | Angle (Deg.) |
| Housing look | 0 .. 659 | 260 | 0 .. 659 | 260 | 0 .. 659 | 260 |

**INS-21 DAA +10V Reference**

This parameter measures the voltage supplied to the data acquisition assembly analog-to-digital converter electronics. The converted value is computed using DRL-64 (Reference ) Linear Coefficients Algorithm listed in . (Count, Volt) [0 .. 4095, 0 .. 16] {Section Voltage - Torque Counts, Section Converted Voltages and Torques}

**INS-22 DAA +12V**

This parameter measures the voltage supplied to the data acquisition assembly analog electronics. This voltage is typically used for the preamp circuitries. The converted value is computed using DRL-64 (Reference ) Linear Coefficients Algorithm listed in . (Count, Volt) [0 .. 4095, 0 ..20] {Section Voltage - Torque Counts, Section Converted Voltages and Torques}

**INS-23 DAA +130V**

This parameter measures the voltage input to the power regulators used to generate the detector +120 volt bias parameter. The converted value is computed using DRL-64 (Reference ) Linear Coefficients Algorithm listed in . (Count, Volt) [0 .. 4095, 0..245.9] {Section Voltage - Torque Counts, Section Converted Voltages and Torques}

**INS-24 DAA +15V**

This parameter measures the voltage supplied to the data acquisition assembly electronics. The converted value is computed using DRL-64 (Reference ) Linear Coefficients Algorithm listed in . (Count, Volt) [0 .. 4095, 0 ..20] {Section Voltage - Torque Counts, Section Converted Voltages and Torques}

**INS-25 DAA +5V**

This parameter measures the voltage supplied to the data acquisition assembly digital electronics. The converted value is computed using DRL-64 (Reference ) Linear Coefficients Algorithm listed in . (Count, Volt) [0 .. 4095, 0 ..8] {Section Voltage - Torque Counts, Section Converted Voltages and Torques}

**INS-26 DAA -10V Reference**

This parameter measures the voltage supplied to the data acquisition assembly analog-to-digital converter electronics. The converted value is computed using DRL-64 (Reference ) Linear Coefficients Algorithm listed in . (Count, Volt) [0 .. 4095, -20..4] {Section Voltage - Torque Counts, Section Converted Voltages and Torques}

**INS-27 DAA -12V**

This parameter measures the voltage supplied to the data acquisition assembly analog electronics. This voltage is typically used for the preamp circuitries. The converted value is computed using DRL-64 (Reference ) Linear Coefficients Algorithm listed in . (Count, Volt) [0 .. 4095, -20..4] {Section Voltage - Torque Counts, Section Converted Voltages and Torques}

**INS-28 DAA -130V**

This parameter measures the voltage input to the power regulators used to generate the detector -120 volt bias parameter. The converted value is computed using DRL-64 (Reference ) Linear Coefficients Algorithm listed in . (Count, Volt) [0 .. 4095, -135.8..-119.6] {Section Voltage - Torque Counts, Section Converted Voltages and Torques}

**INS-29 DAA -15V**

This parameter measures the voltage supplied to the data acquisition assembly electronics. The converted value is computed using DRL-64 (Reference ) Linear Coefficients Algorithm

listed in . (Count, Volt) [0 .. 4095, -20..4] {Section Voltage - Torque Counts, Section Converted Voltages and Torques}

**INS-30 DAA ADC Electronics Temperature**

This parameter measures the temperature of the data acquisition assembly analog-to-digital conversion electronics. The converted value is computed using DRL-64 Algorithm C. For the exact location of this sensor, see DRL-64 (Reference ). (Count, oC) [0 .. 4095, -30 .. 70] {Section Temperature Counts, Section Converted Temperatures}

**INS-31 DAA Ground Reference 1**

**INS-32 DAA Ground Reference 2**

These parameters measure the voltage on the digital acquisition assembly’s ground plane. Ground loop power spikes (e.g., ~0.3 volts) have been noted and can affect radiometric and instrument measurements by the analog-to-digital converter. The converted value is computed using DRL-64 (Reference ) Linear Coefficients Algorithm listed in . (Count, Volt) [0 .. 4095, 0..10] {Section Voltage - Torque Counts, Section Converted Voltages and Torques}

**INS-33 DAA Processor Electronics Temperature**

This parameter measures the temperature of the data acquisition assembly microprocessor electronics. The converted value is computed using DRL-64 Algorithm C. For the exact location of this sensor, see DRL-64 (Reference ). (Count, oC) [0 .. 4095, -30 .. 70] {Section Temperature Counts, Section Converted Temperatures}

**INS-34 DAA Radiator Temperature**

This parameter measures the temperature of the radiator plate for the data acquisition assembly circuit board. The converted value is computed using DRL-64 Algorithm B. For the exact location of this sensor, see DRL-64 (Reference ). (Count, oC) [0 .. 4095, -30 .. 70] {Section Temperature Counts, Section Converted Temperatures}

**INS-35 DAP Maximum Execution Time**

**INS-36 DAP Minimum Execution Time**

**INS-37 ICP Maximum Execution Time**

**INS-38 ICP Minimum Execution Time**

These parameters show the shortest/longest execution time among the 660 DAP/ICP sample periods per packet. These data are written to the BDSP product when the instrument is in the diagnostic processor execution configuration. For the PFM instrument, the minimum time is expected to be in the range of 2-3 milliseconds and the maximum time is expected to be in the range of 5-6 milliseconds. The converted value is computed using DRL-64 (Reference ) Algorithm Linear Coefficients listed in . Note, for the housekeeping data stream, the lower 8 bits, instead of the upper 8 bits are used, resulting in an unusable value for housekeeping monitoring purposes. (milli-sec) [0 .. 10] {Section Converted Instrument Status Data}

**INS-39 DAP Timing**

**INS-40 ICP Timing**

These parameters measures converted DAP and ICP execution time millisecond values.

(milli-msec) [0 .. 10] {Section BDS SDS Summary}

**INS-41 Detector +120V Bias**

**INS-42 Detector -120V Bias**

These parameters measure the voltage for the detector bridge balance circuitry. The converted values are computed using DRL-64 (Reference ) Linear Coefficients Algorithm , and listed in , respectively. (Count, Volt) [0 .. 4095, 115..125, 0 .. 4095, -125..-115] {Section Voltage - Torque Counts, Section Converted Voltages and Torques}

**INS-43 ECA Electronics Temperature**

This parameter measures the temperature of the elevation control assembly electronics. The converted value is computed using DRL-64 Algorithm C. For the exact location of this sensor, see DRL-64 (Reference ). (Count, oC) [0 .. 4095, -30 .. 70] {Section Temperature Counts, Section Converted Temperatures}

**INS-44 ECA Radiator Temperature**

This parameter measures the temperature of the radiator plate for the elevation control assembly circuit board. The converted value is computed using DRL-64 Algorithm C. For the exact location of this sensor, see DRL-64 (Reference ). (Count, oC) [0 .. 4095, -30 .. 70] {Section Temperature Counts, Section Converted Temperatures}

**INS-45 ECA Torque Output**

This parameter measures the elevation gimbal torque converted to a servo controller signal. The converted value is computed using DRL-64 (Reference ) Linear Coefficients Algorithm listed in . (Count, deg) [0 .. 4095, -95.7..95.2] {Section Voltage - Torque Counts, Section Converted Voltages and Torques}

**INS-46 ICA Radiator Temperature**

This parameter measures the temperature of the radiator for the instrument controller assembly circuit board. The converted value is computed using DRL-64 Algorithm C. For the exact location of this sensor, see DRL-64 (Reference ). (Count, oC) [0 .. 4095, -30 .. 70] {Section Temperature Counts, Section Converted Temperatures}

**INS-47 Elevation Bearing Temperature-CW**

**INS-48 Elevation Bearing Temperature-Motor**

These parameters measure the temperatures on the elevation gimbal bearing spindle (motor side and cable wrap side). The converted values are computed using DRL-64 Algorithm C. For the exact location of these sensors, see DRL-64 (Reference ). (Count, oC) [0 .. 4095, -30 .. 70] {Section Temperature Counts, Section Converted Temperatures}

**INS-49 Elevation Error**

This parameter measures converted elevation gimbal error position values that are measured for each sample 0 .. 659. These data are output to a BDSG product when the instrument is in the diagnostic gimbal error configuration. The converted value is computed using DRL-64 (Reference ) Algorithm Linear Coefficients listed in . (deg) [0 .. 360] {Section BDS SDS Summary}

**INS-50 Elevation Offset Correction**

This parameter indicates an internal count adjustment to compensate for the encoder position to actual gimbal position misalignment. This value will reflect the internal default value or the last update by the Set\_Elevation\_Offset\_Correction command. The converted value is computed using DRL-64 (Reference ) Algorithm Linear Coefficients listed in . This value needs to be treated as a signed integer data representation. The default nominal unsigned and signed integer offset values for each instrument, as specified in the flight codes, are shown in . (deg) [0 .. 360] {Section Converted Instrument Status Data}

**INS-51 Elevation Spindle Temperature-CW**

**INS-52 Elevation Spindle Temperature-Motor**

These parameters measure the temperatures on the elevation gimbal spindle (motor side and cable wrap side). The spindle is attached to the mounting plate for the three detector sensor assemblies. The converted values are computed using DRL-64 Algorithm B. For the exact location of these sensors, see DRL-64 (Reference ). (Count, oC) [0 .. 4095, -30 .. 70] {Section Temperature Counts, Section Converted Temperatures}

**INS-53 ICA +10V Bias**

This parameter measures the voltage used by the instrument controller assembly analog to digital converter as a reference signal. The converted value is computed using DRL-64 (Reference ) Linear Coefficients Algorithm listed in . (Count, Volt) [0 .. 4095, 0..12] {Section Voltage - Torque Counts, Section Converted Voltages and Torques}

**INS-54 ICA +15V to ECA/ACA**

This parameter measures the voltage supplied to the elevation and azimuth control assembly electronics. This voltage is used for the gimbal drives. The converted value is computed using DRL-64 (Reference ) Linear Coefficients Algorithm listed in . (Count, Volt) [0 .. 4095, 0..20] {Section Voltage - Torque Counts, Section Converted Voltages and Torques}

**INS-55 ICA + 5V Analog**

This parameter measures the voltage used by the instrument controller assembly analog electronics. These electronics include, for example, the opto-isolator drivers for the ICA/DAA cable wrap. The converted value is computed using DRL-64 (Reference ) Linear Coefficients Algorithm listed in . (Count, Volt) [0 .. 4095, 0..8] {Section Voltage - Torque Counts, Section Converted Voltages and Torques}

**INS-56 ICA +5V Digital**

This parameter measures the voltage supplied to the instrument controller assembly electronics. The converted value is computed using DRL-64 (Reference ) Linear Coefficients Algorithm listed in . (Count, Volt) [0 .. 4095, 0..10] {Section Voltage - Torque Counts, Section Converted Voltages and Torques}

**INS-57 ICA -15V Internal**

This parameter measures the voltage used by the instrument controller assembly. The converted value is computed using DRL-64 (Reference ) Linear Coefficients Algorithm listed in . (Count, Volt) [0 .. 4095, -20..4] {Section Voltage - Torque Counts, Section Converted Voltages and Torques}

**INS-58 ICA +15V Internal**

This parameter measures the voltage supplied to the data acquisition assemblies analog electronics. This voltage is typically used for the preamp circuitries. The converted value is computed using DRL-64 (Reference ) Linear Coefficients Algorithm listed in . (Count, Volt) [0 .. 4095, 0..20] {Section Voltage - Torque Counts, Section Converted Voltages and Torques}

**INS-59 ICA -15V to ECA/ACA**

This parameter measures the voltage supplied to the elevation and azimuth control assembly electronics. This voltage is used for the gimbal drives. The converted value is computed using DRL-64 (Reference ) Linear Coefficients Algorithm listed in . (Count, Volt) [0 .. 4095, -20..4] {Section Voltage - Torque Counts, Section Converted Voltages and Torques}

**INS-60 ICA ADC Electronics Temperature**

This parameter measures the temperature of the instrument controller assembly analog-to-digital conversion electronics. The converted value is computed using DRL-64 Algorithm C. For the exact location of this sensor, see DRL-64 (Reference ). (Count, oC) [0 .. 4095, -30 .. 70] {Section Temperature Counts, Section Converted Temperatures}

**INS-61 ICA Processor Electronics Temperature**

This parameter measures the temperature of the instrument controller assembly microprocessor electronics. The converted value is computed using DRL-64 Algorithm C. For the exact location of this sensor, see DRL-64 (Reference ). (Count, oC) [0 .. 4095, -30 .. 70] {Section Temperature Counts, Section Converted Temperatures}

**INS-62 ICA Radiator Temperature**

This parameter measures the temperature of the radiator for the instrument controller assembly circuit board. The converted value is computed using DRL-64 Algorithm C. For the exact location of this sensor, see DRL-64 (Reference ). (Count, oC) [0 .. 4095, -30 .. 70] {Section Temperature Counts, Section Converted Temperatures}

**INS-63 Instrument ID Number**

This parameter indicates the instrument’s model identification reference. The enumerated values are in , note . (N/A) [0..31] {Section Converted Instrument Status Data}

**INS-64 Main Cover Motor Temperature**

This parameter measures the temperature of the main cover. The converted value is computed using DRL-64 Algorithm C. For the exact location of this sensor, see DRL-64 (Reference ). (Count, oC) [0 .. 4095, -30 .. 70] {Section Temperature Counts, Section Converted Temperatures}

**INS-65 MAM Assembly SW Temperature**

**INS-66 MAM Assembly Total Temperature**

These parameters measure the temperature of the SW MAM and the TOT MAM backing plates. The converted value is computed using DRL-64 Algorithm C. For the exact location of this sensor, see DRL-64 (Reference ). (Count, oC) [0 .. 4095, -30 .. 70] {Section Temperature Counts, Section Converted Temperatures}

**INS-67 MAM Total Baffle Temperature 1**

**INS-68 MAM Total Baffle Temperature 2**

These parameters measure the temperatures near the ends of the total channel MAM baffle assembly. The converted values are computed using DRL-64 Algorithm C. For the exact location of these sensors, see DRL-64 (Reference ). (Count, oC) [0 .. 4095, -30 .. 70] {Section Temperature Counts, Section Converted Temperatures}

**INS-69 Packet Counter - Absolute**

This parameter is a 16-bit counter that is incremented for every instrument-generated CCSDS packet. The count begins with the first packet generated after power-up or a “reset”. Due to the power-up synchronization process, the first packet will most likely be erroneous. (N/A) [0..65536] {Section Converted Instrument Status Data}

**INS-70 Packet Counter - Relative**

This parameter is a 16-bit counter that is always reset to 1 at the beginning of the day by the data processing system. Any data gaps will create a corresponding data gap in the relative packet counter. (N/A) [0..32767] {Section Converted Instrument Status Data}

**INS-71 Packet Data Indicator**

This parameter indicates the type of data in the current packet generated by the instrument. Controlled by the Set\_Science\_Packet\_Type command, this parameter sets both the Application Identifiers (APIDs) type in the packet and the associated byte format for the 660 data records. The enumerated values are in , note . The APIDs are set based on this indicator as shown in . (N/A) [0..6] {Section Converted Instrument Status Data}

Table ‑. APID and Packet Format

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Packet Data Format Type | Input Level-0 Data File by APID | | | |
| Science | Calibration | Diagnostic | Fixed Pattern |
| Normal\_Science | X |  |  |  |
| Calibration |  | X |  |  |
| Memory\_Dump |  |  | X |  |
| Gimbal\_Error |  |  | X |  |
| Execution\_Time |  |  | X |  |
| Fixed\_Pattern (TRMM) |  |  | X |  |
| Fixed\_Pattern (Terra/Aqua/S-NPPP) |  |  |  | X |
| No\_Archive |  |  | X |  |

**INS-72 Packet Data Version**

This parameter indicates the flight code version burned into the Instrument’s EPROMs. The default values for each of the instrument are shown below.

* PFM (TRMM) = 4
* FM 1/FM 2 (Terra) = 5
* FM 3/FM 4 (Aqua) = 6
* FM 5 (S-NPP) = 6

(N/A) [0..31] {Section Converted Instrument Status Data}

**INS-73 Packet Timecode Indicator**

This parameter indicates whether the time stamp for a packet was generated from the spacecraft time-mark or from an instrument internal timer. The spacecraft derived time stamp is computed from the last sample in the packet. It is calculated from the 1 Hz time mark as follows:

Time = # 1Hz tick marks since beginning of the packet +

# secs since tick occurrence to the end of the packet

i.e., #sec adjust = (659-sample# when tick occurred) \* 1\_000\_000

However, if 3 time marks are not received from the spacecraft, then the time stamp will be based on an internally derived instrument time. Also, due to timing collisions between the spacecraft 1Hz signal and the internal instrument 100 Hz signal during the last packet sample, the time stamp may be off by 0.01 seconds. Consequently, the packet to packet time difference could be 6.59 seconds versus the nominal 6.60 seconds. This difference is usually "recovered" by a subsequent 6.61 second difference within a few packets. (N/A) [0..1] {Section Converted Instrument Status Data}

**INS-74 PCA Electronics Temperature**

This parameter measures the temperature of the power converter assembly electronics. The converted value is computed using DRL-64 Algorithm C. For the exact location of this sensor, see DRL-64 (Reference ). (Count, oC) [0 .. 4095, -30 .. 70] {Section Temperature Counts, Section Converted Temperatures}

**INS-75 PCA Radiator Temperature**

This parameter measures the temperature for the radiator for the power converter assembly circuit board. The converted value is computed using DRL-64 Algorithm C. For the exact location of this sensor, see DRL-64 (Reference ). (Count, oC) [0 .. 4095, -30 .. 70] {Section Temperature Counts, Section Converted Temperatures}

**INS-76 Pedestal Temperature 1-Brake Housing**

This parameter measures the temperature of the instrument’s pedestal mount for the azimuth’s brake assembly. The converted value is computed using DRL-64 Algorithm C. For the exact location of this sensor, see DRL-64 (Reference ). (Count, oC) [0 .. 4095, -30 .. 70] {Section Temperature Counts, Section Converted Temperatures}

**INS-77 Pedestal Temperature 2-Isolator**

This parameter measures the temperature of the instrument’s pedestal mount near the spacecraft mounting interface. The converted value is computed using DRL-64 Algorithm C. For the exact location of this sensor, see DRL-64 (Reference ). (Count, oC) [0 .. 4095, -30 .. 70] {Section Temperature Counts, Section Converted Temperatures}

**INS-78 Science Packet Quick Look Status Flag**

This parameter indicates to the ground data processing system that a copy of a packet is to be made and collected into a level-0 file for quick-look science data processing. The enumerated values are in , note . For the CERES instrument on the TRMM spacecraft, this value is expected to be = Flag\_Not\_Set (normal condition). This parameter reflects the Set\_Quicklook\_Flag command. (N/A) [0..1] {Section Converted Instrument Status Data}

**INS-79 Sensor Electronics Temperature**

This parameter measures the temperature of the detector sensor front-end electronics printed circuit card. Since the bridge balance circuits are part of this circuitry, temperature variations may have an influence on the bolometer signals. The converted value is computed using DRL-64 Algorithm B. For the exact location of this sensor, see DRL-64 (Reference ). (Count, oC) [0 .. 4095, -30 .. 70] {Section Temperature Counts, Section Converted Temperatures}

**INS-80 Sensor Module Temperature**

This parameter measures the temperature of the cantilever mounting plate that holds the detector sensor assembly. The sensor is mounted between the WN and SW assemblies. The converted value is computed using DRL-64 Algorithm B. For the exact location of this sensor, see DRL-64 (Reference ) (Count, oC) [0 .. 4095, -30 .. 70] {Section Temperature Counts, Section Converted Temperatures}

**INS-81 SW Detector Control Temperature**

**INS-82 TOT Detector Control Temperature**

**INS-83 WN Detector Control Temperature**

These parameters measure the temperature measured by the detector’s heatsink control sensor. The converted values are computed using DRL-64 Algorithm 2 - The Sensor Control Temperature (SCT) conversion equations for the SW, TOT, and WN channels are: For the exact location of these sensors, see DRL-64 (Reference ). Note: for the FM 2 instrument, the total channel control temperature parameter will read false values and is not to be used. (Count, oC) [0 .. 4095, 36 .. 40] {Section Temperature Counts, Section Converted Temperatures}

**INS-84 SW Detector Monitor Temperature**

**INS-85 TOT Detector Monitor Temperature**

**INS-86 WN Detector Monitor Temperature**

These parameters measure the temperature measured by the detector’s heatsink monitor sensors. These secondary sensors are used by the heatsink temperature control algorithm for maintaining the required tightness temperatures. (See section on heatsink temperature algorithms for operational details.) However, these sensors are the primary monitoring sensors used by the radiometric count conversion process. The converted value is computed using DRL-64 Algorithm A. For the exact location of these sensors, see DRL-64 (Reference ). (Count, oC) [0 .. 4095, 36 .. 40] {Section Temperature Counts, Section Converted Temperatures}

**INS-87 SWICS Lamp Current**

This parameter measures the current being drawn by the SWICS photodiode lamp. Values should be seen only when an internal calibration is performed. The converted value is computed using DRL-64 (Reference ) Linear Coefficients Algorithm listed in . (Count, mA) [0 .. 4095, 0 .. 115] {Section Voltage - Torque Counts, Section Converted Voltages and Torques}

**INS-88 SWICS Photodiode Temperature**

This parameter measures the temperature of the SWICS photodiode mounting base. The mounting base is not temperature controlled. The converted value is computed using DRL-64 Algorithm C. For the exact location of this sensor, see DRL-64 (Reference ). (Count, oC) [0 .. 4095, -30 .. 70] {Section Temperature Counts, Section Converted Temperatures}

**INS-89 TOT Blackbody Temperature**

**INS-90 WN Blackbody Temperature**

These parameters measures the temperature measured by the blackbody’s heatsink sensor. The TOT blackbody sensor is the primary sensor used by the temperature control algorithm for maintaining the required blackbody temperatures. There is no secondary sensor, though the WN blackbody sensor is available. The converted values are computed using DRL-64 Algorithm 1 - The Platinum Resistance Thermometer (PRT) conversion equations for the blackbody total and window channels are: (See section on heatsink temperature algorithms for operational details.) For the exact location of these sensors, see DRL-64 (Reference ). (Count, oC) [0 .. 4095, -15 .. 60] {Section Temperature Counts, Section Converted Temperatures}

#### Level-0 Parameter Descriptions

The parameters described in this section have no converted value and are copied from the Level-0 input files to the BDS. The Level-0 parameters that have a complimentary converted value are found in the section under the Instrument Parameters (See Section ). An alphabetical listing of the Level-0 parameters is given in .

LVL-1 ACA Encoder Clear Track A

LVL-2 ACA Encoder Clear Track B

These parameters indicates the raw count values for the azimuth encoder track A and track B as read from the LED. (count) [0 .. 4095] {Section Position Counts}

LVL-3 Azimuth Brake Position

This parameter indicates the raw count value for the brake position encoder. (count) [0 .. 4095] {Section Position Counts}

LVL-4 Azimuth Error Counts

This parameter indicates raw azimuth gimbal error (commanded versus actual difference) position count values, copied from the input Level-0 data files. These data are output to a BDSG product when the instrument is in the diagnostic gimbal error configuration. (count) [0 .. 65535] {Section BDS SDS Summary}

LVL-5 Azimuth Position Count

This parameter indicates the raw azimuth gimbal position count value from sample 351, copied from the input Level-0 data files. illustrates the synchronous and asynchronous profiles currently available when the instrument is in RAPS model. The asynchronous profile will be the nominal mission profile. (count) [0 .. 4095] {Section BDS SDS Summary}

LVL-6 Blackbody Heater DAC Value

This parameter represents the commanded power value used to control the heatsink temperature. This value is derived from internal flight code equations that use the A0, A1, B1, and D0

commanded coefficients. See Section for the derived equations as copied from the Instrument Operations Manual (Reference ). (count) [0 .. 4095] {Section Position Counts}

LVL-7 DAP Memory

LVL-8 ICP Memory

These parameters indicates the raw DAP and ICP memory word count values, copied from the input Level-0 data files. These data are only output to a BDSM product when the instrument is in the diagnostic memory dump configuration. The memory dump can be used to check the proper operation of the instrument processors. (count) [0 .. 65535] {Section BDS SDS Summary}

LVL-9 DAP Timing Counts

LVL-10 ICP Timing Counts

These parameters measures the raw DAP (Data Acquisition microProcessor) and ICP (Instrument Control microProcessor) execution time count values, copied from the input Level-0 data files. These data are only output to a BDSP product when the instrument is in the diagnostic memory dump configuration. (count) [0 .. 65535] {Section BDS SDS Summary}

LVL-11 ECA Encoder Clear Track A

LVL-12 ECA Encoder Clear Track B

These parameters indicates the raw count values for the elevation encoder track A and track B as read from the LED. (count) [0 .. 4095] {Section Position Counts}

LVL-13 Elevation Error Counts

This parameter indicates raw elevation gimbal error (commanded versus actual difference) position count values, copied from the input Level-0 data files. These data are output to a BDSG product when the instrument is in the diagnostic gimbal error configuration. (count) [0 .. 65535] {Section BDS SDS Summary}

LVL-14 Elevation Position Count

This parameter indicates the raw elevation gimbal position count value for samples 120, 336, 505, copied from the input Level-0 data files. through list the profiles for the normal-earth scan, short-earth scan, nadir-earth scan, and MAM scan, respectively. See for a sketch of the elevation profiles. Note, for Level-0 data, measurement samples are referenced as 0 .. 659, whereas, for the Level-1b BDS files, the measurement samples are referenced 1 .. 660. (count) [0 .. 4095] {Section BDS SDS Summary}

LVL-15 Fixed Pattern 1

LVL-16 Fixed Pattern 2

LVL-17 Fixed Pattern 3

LVL-18 Fixed Pattern 4

LVL-19 Fixed Pattern 5

LVL-20 Fixed Pattern 6

These parameters indicates raw count values for the first through sixth word in a fixed pattern record, copied from the input Level-0 data files. These data are only output to a BDSF product when the instrument is in the diagnostic fixed pattern configuration. These patterns are used for communication tests. It has been observed on the PFM instrument that the values for words 3 .. 6 will not be accurate due to bit format alignment problems in the flight code. This will be rechecked for the FM 1 and FM 2 instruments. (count) [0 .. 65535, 0 .. 4095 ] {Section Position Counts}

* **Word 1** substitutes for the azimuth parameter, nominally = 10000 + (n \* 60)
* **Word 2** substitutes for the elevation parameter, nominally = 20000 + (n \* 60)
* **Word 3** substitutes for the TOT radiometric parameter, nominally = 1000 + n
* **Word 4** substitutes for the WN radiometric parameter, nominally = 3000 + n
* **Word 5** substitutes for the SW radiometric parameter, nominally = 2000 + n
* **Word 6** substitutes for the analog engineering parameter as denoted by DRL-64   
  (Figure 2-1 in Reference ). The values correspond to the submux channel   
  (See ).

The value n represents the instrument sample number within a scan ranging from 0 to 659.

LVL-21 Main Cover Position 1

LVL-22 Main Cover Position 2

These parameters indicates the raw count values for the linear screw drive encoders for the main cover rail number 1 and rail number 2. (count) [0 .. 4095] {Section Position Counts}

LVL-23 MAM Cover Position

These parameter indicates the raw count value for the MAM cover drive encoder. (count) [0 .. 4095] {Section Position Counts}

LVL-24 MAM Cover Position Status

This parameter indicates where the cover is currently positioned as of the last sample in the packet. See , note . During nominal mission operations, this status should generally indicate Cover\_At\_Opened\_Position (1). However, it may also indicate Potentially\_Failed\_Position\_Sensor. This indicator simply means that the cover “overshot” its defined opened (or closed) position and is not indicative of a problem. There are no plans to move the cover after initial on-orbit instrument checkout. (count) [0 .. 4095] {Section Position Counts}

LVL-25 Raw Instrument Status Data

This parameter represents the block of status data for each packet, copied from the input Level-0 data files. See for details. (N/A)

LVL-26 Spacecraft Time

This parameter indicates the raw telemetry packet secondary header time stamp, copied from the input Level-0 data files. (count) [0 .. 255] {Section BDS SDS Summary}

LVL-27 SPS 1 Narrow **FOV**

LVL-28 SPS 1 Wide **FOV**

LVL-29 SPS 2 Narrow FOV

LVL-30 SPS 2 Wide FOV

These parameters indicates the count values from the solar presence sensor narrow/wide FOV circuitries. Values indicate that light (typically Sun light) is being detected within the narrow/wide FOV window, and are input to the solar warning evaluation algorithms. The wide FOV is also used to determine the threshold level for the narrow FOV. (See : on Solar Avoidance for further details.) (count) [0 .. 4095] {Section Position Counts}

LVL-31 SW Channel Heater DAC Value

LVL-32 Total Channel Heater DAC Value

LVL-33 WN Channel Heater DAC Value

These parameters indicates the commanded power values used to control the heatsink temperature for each radiometer channel. The values are derived from internal flight code equations that use the A0, A1, B1, and D0 commanded coefficients. See Section for the derived equations as copied from the Instrument Operations Manual (Reference ). (count) [0 .. 4095] {Section Position Counts}

LVL-34 SW Detector Outputs

LVL-35 TOT Detector Outputs

LVL-36 WN Detector Outputs

These parameters measures the raw SW, TOT, and WN detector count values, copied from the input Level-0 data files containing the three radiometric channels from the CERES scanning instrument. Each detector measurement at satellite altitude has a range of 0 - 4095 counts. The algorithm for converting raw radiometric data in digital counts into filtered radiance is in the section on calibration (See Reference ). (count) [0 .. 4095] {Section Position Counts}

LVL-37 SWICS Photodiode Output

This parameter measures the digital counts as sent to the SWICS lamp driver circuitry. This value should be zero when the lamp is off. When the lamp is on, the values for each intensity level is approximately 170, 1401, and 3145 1 count, which corresponds roughly to 100, 250, and 400 Wm-2sr-1, respectively. (count) [0 .. 4095] {Section Temperature Counts}.

### Fill Values

lists the default CERES Fill Values. These are used when data are missing, when there are insufficient data to make a calculation, or when data are suspect. Suspect values are values that were calculated but failed edit checks.

Table ‑. CERES Fill Values

|  |  |  |
| --- | --- | --- |
| **Fill Value Name** | **Value** | **Fill Value Description**\* |
| INT1\_DFLT | 127 | default value for a 1-byte integer |
| INT2\_DFLT | 32767 | default value for a 2-byte integer |
| INT4\_DFLT | 2147483647 | default value for a 4-byte integer |
| REAL4\_DFLT | 3.4028235E+38 | default value for a 4-byte real |
| REAL8\_DFLT | 1.7976931348623157E+308 | default value for a 8-byte real |

\* 1 byte = 8 bits

### Data Types

The following data types are used to represent numerical parameters in the BDS:

Table ‑. Data Types and Formats

|  |  |  |
| --- | --- | --- |
| Data Type | Range | Format |
| Unsigned 8 Bit Integer | 0..255 | N/A |
| Signed 8 Bit Integer | -127..127 | N/A |
| Unsigned 16 Bit Integer | 0..65536 | N/A |
| Signed 16 Bit Integer | -32767..32767 | N/A |
| Unsigned 32 Bit Integer | 0..4294967296 | N/A |
| Signed 32 Bit Integer | -2147483648..2147483648 | N/A |
| 32 Bit Float | platform dependent | 11.6 |
| 64 Bit Float | platform dependent | 13.8 |

# Data Organization

This section discusses the organization of the BDS structures as written to the output data file. All BDS data products use Hierarchical Data Format (HDF) structures such as Vertex Data (Vdata) and Scientific Data Sets (SDSs). See the HDF User’s Guide for additional information (Reference ). BDS Metadata is implemented using the ECS ToolKit metadata routines (Reference ), which are based on HDF Annotations.

## Data Granularity

All BDS data granules consist of no more than 24 hours of data from one CERES instrument.

## Data Format

All BDS data granules are stored in the HDF developed by the National Center for Supercomputing Applications (NCSA). The HDF permits aggregation of commonly used data structures within a single file, and a common, platform independent Application Programming Interface (API). The BDS product contains HDF SDSs and Vdata structures.

### Scientific Data Sets (SDS)

A Scientific Data Set is an HDF structure capable of storing large quantities of a single data type. SDSs are organized by dimensions, and a single SDS can have up to 32 dimensions. By design, SDSs within the BDS are limited to two dimensions. A 2-dimensional SDS is analogous to a spreadsheet with *m* columns and *n* rows. This allows a time ordered mapping of CERES scanner sampling data to the SDS data structure. Such a mapping is shown in , where a single SDS row corresponds to a packet of data or record, and each column in the row corresponds to a sample measurement within a packet. Consequently, the number of rows in a given BDS SDS will depend on the number of scanner records processed. Most of the SDSs have 660 samples per packet of a single parameter arranged as shown in .

Value

Value

Value

Value

Value

Value

Value

Value

Value

Value

Value

Value

Value

Value

Value

Value

Value

Value

Value

Value

Sample 2

Sample 3

Sample 4

Sample 5

Sample 1

Value

Value

Value

Value

Sample 660

Packet 1

Packet 2

Packet 3

Packet n

n = the number of packets processed

Figure ‑. BDS SDS schematic

### BDS SDS Summary

lists the parameters that are stored as SDSs. The entries in the Link and SDS Name columns are hyperlinked to a definition of the parameter. The HDF rank of all BDS SDSs is 2 (2-dimensional arrays). The size column specifies the dimensions where n is the number of packets. The HDF data type, the size of the SDS, and which products contain each SDS are also shown in the summary table. The key for the Product Types is in the summary table header.

| Table ‑. BDS Scientific Data Set (SDS) Summary | | | | | |
| --- | --- | --- | --- | --- | --- |
| Link | SDS Name | Size | Data Type | Nominal  Size MB | BDS Product  Types |
|  | Ancillary QA Flags Set 1 (Radiance Housekeeping) | 660 x n | U32 bit Integer |  | A, S, D, --, G, M, P |
|  | Ancillary QA Flags Set 2 (Spaceclamp Algorithm) | 660 x n | U32 bit integer |  | A, S, D, --, G, M, P |
|  | CERES Relative Azimuth at Surface | 660 x n | 32 bit float |  | A, S, D, --, G, M, P, I |
|  | CERES Relative Azimuth at TOA - Geocentric | 660 x n | 32 bit float |  | A, S, D, --, G, M, P, I |
|  | CERES Solar Zenith at Surface | 660 x n | 32 bit float |  | A, S, D, --, G, M, P, I |
|  | CERES Solar Zenith at TOA - Geocentric | 660 x n | 32 bit float |  | A, S, D, --, G, M, P, I |
|  | CERES SW Filtered Radiance, Upwards | 660 x n | 32 bit float |  | A, S, D, --, --, --, --, I |
|  | CERES TOT Filtered Radiance, Upwards | 660 x n | 32 bit float |  | A, S, D, --, --, --, --, I |
|  | CERES Viewing Zenith at Surface | 660 x n | 32 bit float |  | A, S, D, --, G, M, P, I |
|  | CERES Viewing Zenith at TOA - Geocentric | 660 x n | 32 bit float |  | A, S, D, --, G, M, P, I |
|  | CERES WN Filtered Radiance, Upwards | 660 x n | 32 bit float |  | A, S, D, --, --, --, --, I |
|  | Clock Angle of CERES FOV at Satellite wrt Inertial Velocity | 660 x n | 32 bit float |  | A, S, D, --, G, M, P, I |
|  | Colatitude of CERES FOV at Surface | 660 x n | 32 bit float |  | A, S, D, --, G, M, P, I |
|  | Colatitude of CERES FOV at TOA | 660 x n | 32 bit float |  | A, S, D, --, G, M, P, I |
|  | Cone Angle of CERES FOV at Satellite | 660 x n | 32 bit float |  | A, S, D, --, G, M, P, I |
|  | Count Conversion SW Sample Offsets | 660 x 4 | 32 bit float |  | A, S, D, --, --, --, --, I |
|  | Count Conversion TOT Sample Offsets | 660 x 4 | 32 bit float |  | A, S, D, --, --, --, --, I |
|  | Count Conversion WN Sample Offsets | 660 x 4 | 32 bit float |  | A, S, D, --, --, --, --, I |
|  | Drift Corrected SW Counts | 660 x n | 32 bit float |  | A, S, D, --, --, --, --, I |
|  | Drift Corrected TOT Counts | 660 x n | 32 bit float |  | A, S, D, --, --, --, --, I |
|  | Drift Corrected WN Counts | 660 x n | 32 bit float |  | A, S, D, --, --, --, --, I |
|  | Julian Date and Time | 2 x n | 64 bit float |  | A, S, D, F, G, M, P, I |
|  | Longitude of CERES FOV at Surface | 660 x n | 32 bit float |  | A, S, D, --, G, M, P, I |
|  | Longitude of CERES FOV at TOA | 660 x n | 32 bit float |  | A, S, D, --, G, M, P, I |
|  | Primary Scan Level QA Flags | 1 x n | U32 bit integer |  | A, S, D, --, G, M, P, I |
|  | Radiance and Mode Flags | 660 x n | U32 bit integer |  | A, S, D, --, G, M, P, I |
|  | Rate of Change of Clock Angle | 660 x n | 32 bit float |  | A, S, D, --, G, M, P, I |
|  | Rate of Change of Cone Angle | 660 x n | 32 bit float |  | A, S, D, --, G, M, P, I |
|  | Sample Aligned Analog Data | 660 x n | U16 bit integer |  | A, S, D, F, G, M, P, I |
|  | Secondary Sample Level QA Flags | 660 x n | U16 bit integer |  | A, S, D, --, G, M, P, I |
|  | Secondary Scan Level QA Flags | 1 x n | U16 bit integer |  | A, S, D, --, G, M, P, I |
|  | SW Spaceclamp Values | 2 x n | 32 bit float |  | A, S, D, --, --, --, --, I |
|  | TOT Spaceclamp Values | 2 x n | 32 bit float |  | A, S, D, --, --, --, --, I |
|  | TOT Spaceclamp Values | 2 x n | 32 bit float |  | A, S, D, --, --, --, --, I |
|  | SW Slow Mode and Drift Corrected Counts | 660 x n | 32 bit float |  | A, S, D, --, --, --, --, I |
|  | TOT Slow Mode and Drift Corrected Counts | 660 x n | 32 bit float |  | A, S, D, --, --, --, --, I |
|  | WN Slow Mode and Drift Corrected Counts | 660 x n | 32 bit float |  | A, S, D, --, --, --, --, I |
|  | Lunar Azimuth Angles | 660 x n | 32 bit float |  | A, S, D, --, --, --, --, I |
|  | Lunar Elevation Angles | 660 x n | 32 bit float |  | A, S, D, --, --, --, --, I |
|  | Solar Azimuth Angles | 660 x n | 32 bit float |  | A, S, D, --, --, --, --, I |
|  | Solar Elevation Angles | 660 x n | 32 bit float |  | A, S, D, --, --, --, --, I |
|  | Solar Calibration MAM FOV Azimuth Angles | 660 x n | 32 bit float |  | A, S, D, --, --, --, --, I |
|  | Solar Calibration MAM FOV Elevation Angles | 660 x n | 32 bit float |  | A, S, D, --, --, --, --, I |
|  | Converted Azimuth Angles | 660 x n | 32 bit float |  | A, S, D, --, G, M, P, I |
|  | Azimuth Position Error | 660 x n | 32 bit float |  | G |
|  | Converted Elevation Angles | 660 x n | 32 bit float |  | A, S, D, --, G, M, P, I |
|  | Elevation Error | 660 x n | 32 bit float |  | G |
|  | DAP Timing | 660 x n | 32 bit float |  | P |
|  | ICP Timing | 660 x n | 32 bit float |  | P |
|  | Azimuth Error Counts | 660 x n | U16 bit integer |  | G |
|  | Azimuth Position Count | 660 x n | U16 bit integer |  | A, S, D, --, G, M, P, I |
|  | DAP Timing Counts | 660 x n | U16 bit integer |  | P |
|  | Elevation Position Count | 660 x n | U16 bit integer |  | A, S, D, --, G, M, P, I |
|  | Fixed Pattern 1 | 660 x n | U16 bit integer |  | F |
|  | Fixed Pattern 2 | 660 x n | U16 bit integer |  | F |
|  | Fixed Pattern 3 | 660 x n | U16 bit integer |  | F |
|  | Fixed Pattern 4 | 660 x n | U16 bit integer |  | F |
|  | Fixed Pattern 5 | 660 x n | U16 bit integer |  | F |
|  | Fixed Pattern 6 | 660 x n | U16 bit integer |  | F |
|  | ICP Timing Counts | 660 x n | U16 bit integer |  | P |
|  | Elevation Error Counts | 660 x n | U16 bit integer |  | G |
|  | DAP Memory | 660 x n | U16 bit integer |  | M |
|  | ICP Memory | 660 x n | U16 bit integer |  | M |
|  | Raw Instrument Status Data | 185 x n | U16 bit integer |  | A, S, D, F, G, M, P, I |
|  | SW Detector Outputs | 660 x n | U16 bit integer |  | A, S, D, --, --, --, --, I |
|  | TOT Detector Outputs | 660 x n | U16 bit integer |  | A, S, D, --, --, --, --, I |
|  | WN Detector Outputs | 660 x n | U16 bit integer |  | A, S, D, --, --, --, --, I |
|  | Spacecraft Time | 8 x n | U8 bit integer |  | M |
| (\*) A=BDS, S=BDSS, D=BDSD, F=BDSF, G=BDSG, M=BDSM, P=BDSP, I=BDSI  \*\* These SDSs are available on Aqua and Terra Edition1 BDSs beginning with CC-Code 027025 and Aqua and Terra Edition2 BDSs beginning with CC-Code 028028. | | | | | |

### Vertex Data (VData)

A Vdata is an HDF structure that allows record-based storage of multiple parameters and/or multiple data types as shown in the example in . Vdata records are analogous to records found in relational database systems where a single record is composed of one or more data fields, and each data field can be represented by its own data type.

|  |  |  |  |
| --- | --- | --- | --- |
| Field 1 Unsigned 16 bit Integer | Field 2 32 bit Floats | | Field 3 Signed 8 bit Integer |
| Value | Value 1 | Value 2 | Value |

Figure ‑. Vdata record example

is a summary of the Vdata structures contained in the BDS products. Following the summary table are tables that list the components of each of the Vdatas. These tables represent the Vdata structures as written to the data products. The data descriptions are hyperlinked from the Parameter Name column in each of the tables.

Table ‑. Vdata Summary

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Vdata Name | Section Link | Records | Number of  Fields | Nominal  Size (MB) | BDS Product Types (\*) |
| Converted Instrument Status Data | Sec. | n | 25 | 1.1 | A, S, D, F, G, M, P, I |
| Converted Temperatures | Sec. | n | 35 | 8.84 | A, S, D, --, G, M, P, I |
| Converted Voltages and Torques | Sec. | n | 23 | 4.35 | A, S, D, --, G, M, P, I |
| Count Conversion Constants | Sec. | 1 | 9 | ~0.0 | A, S, D, --, --, --, --, I |
| Position Counts | Sec. | n | 12 | 6.6 | A, S, D, --, G, M, P, I |
| Satellite - Celestial Data | Sec. | n | 11 | 1.6 | A, S, D, F, G, M, P, I |
| Temperature Counts | Sec. | n | 39 | 5.62 | A, S, D, --, G, M, P, I |
| Voltage - Torque Counts | Sec. | n | 24 | 2.25 | A, S, D, --, G, M, P, I |
| **Vdata Total Size** |  |  |  | 30.36 |  |
| (\*) A=BDS, S=BDSS, D=BDSD, F=BDSF, G=BDSG, M=BDSM, P=BDSP, I=BDSI | | | | | |

#### Converted Instrument Status Data

BDS Product Types: BDS, BDSS, BDSD, BDSF, BDSM, BDSG, BDSP, BDSI

This data set contains the converted values for instrument status parameters that have defined conversion algorithms. Packet status information that is not part of the raw digital status data block is also included in this data set.

| Table ‑. Converted Instrument Status Data Field Summary | | | | |
| --- | --- | --- | --- | --- |
| Link | Field  Num | Parameter Name | Order | Data Type |
|  | 1 | Elevation Offset Correction | 1 | 32 bit float |
|  | 2 | Azimuth Offset Correction | 1 | 32 bit float |
|  | 3 | Azimuth Defined Crosstrack Position | 1 | 32 bit float |
|  | 4 | Azimuth Defined Fixed Position A | 1 | 32 bit float |
|  | 5 | Azimuth Defined Fixed Position B | 1 | 32 bit float |
|  | 6 | Azimuth Defined Fixed Solar Calibration Position | 1 | 32 bit float |
|  | 7 | Azimuth Defined Fixed Cage Position | 1 | 32 bit float |
|  | 8 | Azimuth Defined Fixed Position Spare 1 | 1 | 32 bit float |
|  | 9 | Azimuth Defined Fixed Position Spare 2 | 1 | 32 bit float |
|  | 10 | Azimuth Defined Fixed Position Spare 3 | 1 | 32 bit float |
|  | 11 | Azimuth Defined Normal Slew Rate | 1 | 32 bit float |
|  | 12 | Azimuth Defined Asynchronous Scan Rate | 1 | 32 bit float |
|  | 13 | Azimuth Defined Synchronous Scan Rate | 1 | 32 bit float |
|  | 14 | Azimuth Position Error | 1 | 32 bit float |
|  | 15 | DAP Minimum Execution Time | 1 | 32 bit float |
|  | 16 | DAP Maximum Execution Time | 1 | 32 bit float |
|  | 17 | ICP Minimum Execution Time | 1 | 32 bit float |
|  | 18 | ICP Maximum Execution Time | 1 | 32 bit float |
|  | 19 | Instrument ID Number | 1 | Unsigned 16 bit integer |
|  | 20 | Packet Data Indicator | 1 | Unsigned 16 bit integer |
|  | 21 | Packet Data Version | 1 | Unsigned 16 bit integer |
|  | 22 | Science Packet Quick Look Status Flag | 1 | Unsigned 16 bit integer |
|  | 23 | Packet Timecode Indicator | 1 | Unsigned 16 bit integer |
|  | 24 | Packet Counter - Relative | 1 | Unsigned 16 bit integer |
|  | 25 | Packet Counter - Absolute | 1 | Unsigned 32 bit integer |
|  | Record Size (bytes) | | | 92 |

#### Converted Temperatures

BDS Product Types: BDS, BDSS, BDSD, BDSM, BDSG, BDSP, BDSI

This data set contains the converted values for instrument temperature parameters. The data descriptions apply to both the Temperature Counts () parameters and the Converted Temperatures listed in . The Link and Parameter Name columns are hyperlinked from the tables to the parameter description.

| Table ‑. Converted Temperatures Field Summary | | | | |
| --- | --- | --- | --- | --- |
| Link | Field  Num | Parameter Name | Order | Data Type |
|  | 1 | TOT Detector Control Temperature | 12 | 32 bit float |
|  | 2 | TOT Detector Monitor Temperature | 12 | 32 bit float |
|  | 3 | SW Detector Control Temperature | 12 | 32 bit float |
|  | 4 | SW Detector Monitor Temperature | 12 | 32 bit float |
|  | 5 | WN Detector Control Temperature | 12 | 32 bit float |
|  | 6 | WN Detector Monitor Temperature | 12 | 32 bit float |
|  | 7 | TOT Blackbody Temperature | 12 | 32 bit float |
|  | 8 | WN Blackbody Temperature | 12 | 32 bit float |
|  | 9 | Elevation Spindle Temperature-Motor | 3 | 32 bit float |
|  | 10 | Elevation Spindle Temperature-CW | 3 | 32 bit float |
|  | 11 | Elevation Bearing Temperature-Motor | 3 | 32 bit float |
|  | 12 | Elevation Bearing Temperature-CW | 3 | 32 bit float |
|  | 13 | SWICS Photodiode Temperature | 3 | 32 bit float |
|  | 14 | Sensor Module Temperature | 3 | 32 bit float |
|  | 15 | Sensor Electronics Temperature | 3 | 32 bit float |
|  | 16 | Main Cover Motor Temperature | 3 | 32 bit float |
|  | 17 | MAM Total Baffle Temperature 1 | 3 | 32 bit float |
|  | 18 | MAM Total Baffle Temperature 1 | 3 | 32 bit float |
|  | 19 | MAM Assembly SW Temperature | 3 | 32 bit float |
|  | 20 | MAM Assembly SW Temperature | 3 | 32 bit float |
|  | 21 | DAA Radiator Temperature | 3 | 32 bit float |
|  | 22 | DAA Processor Electronics Temperature | 3 | 32 bit float |
|  | 23 | DAA ADC Electronics Temperature | 3 | 32 bit float |
|  | 24 | ECA Radiator Temperature | 3 | 32 bit float |
|  | 25 | ECA Electronics Temperature | 3 | 32 bit float |
|  | 26 | ACA Electronics Temperature | 3 | 32 bit float |
|  | 27 | Azimuth Lower Bearing Temperature | 3 | 32 bit float |
|  | 28 | Azimuth Upper Bearing Temperature | 3 | 32 bit float |
|  | 29 | ICA Radiator Temperature | 3 | 32 bit float |
|  | 30 | ICA Processor Electronics Temperature | 3 | 32 bit float |
|  | 31 | ICA ADC Electronics Temperature | 3 | 32 bit float |
|  | 32 | PCA Radiator Temperature | 3 | 32 bit float |
|  | 33 | PCA Electronics Temperature | 3 | 32 bit float |
|  | 34 | Pedestal Temperature 1-Brake Housing | 3 | 32 bit float |
|  | 35 | Pedestal Temperature 2-Isolator | 3 | 32 bit float |
|  | Record Size (bytes) | | | 708 |

#### Converted Voltages and Torques

BDS Product Types: BDS, BDSS, BDSD, BDSM, BDSG, BDSP, BDSI

This data set contains the converted values for instrument voltage, current, and gimbal torque parameters. The data descriptions apply to both the Voltage - Torque Counts Field Summary ( and the Converted Voltages and Torques Field Summary listed in . The Link and Parameter Name columns are hyperlinked from the tables to the parameter description.

Table ‑. Converted Voltages and Torques Field Summary

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Link | Field  Num | Parameter Name | Order | Data Type |
|  | 1 | Detector +120V Bias | 3 | 32 bit float |
|  | 2 | Detector -120V Bias | 3 | 32 bit float |
|  | 3 | SWICS Lamp Current | 3 | 32 bit float |
|  | 4 | ICA +5V Digital | 3 | 32 bit float |
|  | 5 | ICA +15V to ECA/ACA | 3 | 32 bit float |
|  | 6 | ICA -15V to ECA/ACA | 3 | 32 bit float |
|  | 7 | ICA + 5V Analog | 3 | 32 bit float |
|  | 8 | ICA +10V Bias | 3 | 32 bit float |
|  | 9 | ICA +15V Internal | 3 | 32 bit float |
|  | 10 | ICA -15V Internal | 3 | 32 bit float |
|  | 11 | DAA Ground Reference 1 | 3 | 32 bit float |
|  | 12 | DAA Ground Reference 2 | 3 | 32 bit float |
|  | 13 | DAA -10V Reference | 3 | 32 bit float |
|  | 14 | DAA +130V | 3 | 32 bit float |
|  | 15 | DAA -130V | 3 | 32 bit float |
|  | 16 | DAA +12V | 3 | 32 bit float |
|  | 17 | DAA -12V | 3 | 32 bit float |
|  | 18 | DAA +15V | 3 | 32 bit float |
|  | 19 | DAA -15V | 3 | 32 bit float |
|  | 20 | DAA +5V | 3 | 32 bit float |
|  | 21 | DAA +10V Reference | 3 | 32 bit float |
|  | 22 | ECA Torque Output | 12 | 32 bit float |
|  | 23 | ACA Torque Output | 12 | 32 bit float |
|  | Record Size (bytes) | | | 348 |

#### Count Conversion Constants

BDS Product Types: BDS, BDSS, BDSD, BDSI

This Vdata contains a single record of static constants which are used in the radiometric count conversion process (See and ). For detailed information on the count conversion equations, see Reference . These tables represent the Vdata structures as written to the data products. The data descriptions are hyperlinked from the Link and Parameter Name columns.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Channel Gain Constants | | | | | | | | | | | | | | | | | | Slow Mode Constants | | | | | | Edit Limits | | | | | |
| Field 1 - SW | | | | | | Field 2 - WN | | | | | | Field 3 - TOT | | | | | | Field 4 SW | | Field 5 WN | | Field 6 TOT | | Field 7 SW | | Field 8 WN | | Field 9 TOT | |
| AV | AVA | AHA | AD | AB | C | AV | AVA | AHA | AD | AB | C | AV | AVA | AHA | AD | AB | C | λ | c | λ | c | λ | c | Min | Max | Min | Max | Min | Max |

Figure ‑. Count Conversion Constants Vdata Record Structure

Table ‑. Count Conversion Constants Field Summary

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Field  Num | Link | Parameter Name | Order | Data Type |
| 1 |  | SW Channel Gain Constants | 6 | 32 bit float |
| 2 |  | WN Channel Gain Constants | 6 | 32 bit float |
| 3 |  | TOT Channel Gain Constants | 6 | 32 bit float |
| 4 |  | SW Channel Spurious Slow Mode Constants | 2 | 32 bit float |
| 5 |  | WN Channel Spurious Slow Mode Constants | 2 | 32 bit float |
| 6 |  | TOT Channel Spurious Slow Mode Constants | 2 | 32 bit float |
| 7 |  | SW Radiance Edit Limits | 2 | 32 bit float |
| 8 |  | WN Radiance Edit Limits | 2 | 32 bit float |
| 9 |  | TOT Radiance Edit Limits | 2 | 32 bit float |
| Record Size (bytes) | | | |  |

#### Position Counts

BDS Product Types: DS, BDSS, BDSD, BDSM, BDSG, BDSP, BDSI

This data set contains the raw count values for instrument gimbal, covers, and solar position parameters, copied from the Level-0 input data files.

| Table ‑. Position Counts Field Summary | | | | |
| --- | --- | --- | --- | --- |
| Field  Num | Link | Field Name/Parameter | Order | Data Type |
| 1 |  | ACA Encoder Clear Track A | 3 | Unsigned 16 bit integer |
| 2 |  | ACA Encoder Clear Track B | 3 | Unsigned 16 bit integer |
| 3 |  | ECA Encoder Clear Track B | 3 | Unsigned 16 bit integer |
| 4 |  | ECA Encoder Clear Track B | 3 | Unsigned 16 bit integer |
| 5 |  | Main Cover Position 1 | 3 | Unsigned 16 bit integer |
| 6 |  | Main Cover Position 2 | 3 | Unsigned 16 bit integer |
| 7 |  | MAM Cover Position | 3 | Unsigned 16 bit integer |
| 8 |  | Azimuth Brake Position | 3 | Unsigned 16 bit integer |
| 9 |  | SPS 1 Narrow FOV | 60 | Unsigned 16 bit integer |
| 10 |  | SPS 1 Wide FOV | 60 | Unsigned 16 bit integer |
| 11 |  | SPS 2 Narrow FOV | 60 | Unsigned 16 bit integer |
| 12 |  | SPS 2 Wide FOV | 60 | Unsigned 16 bit integer |
| Record Size (bytes) | | | | 528 |

#### Satellite - Celestial Data

BDS Product Types: BDS, BDSS, BDSD, BDSF, BDSM, BDSG, BDSP, BDSI

This Vdata contains spacecraft and celestial converted values. The Link and Parameter Name column entries are hyperlinked to the parameter description.

Table ‑. Satellite - Celestial Data Field Summary

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Field  Num | Link | Parameter Name | Order | Data Type |
| 1 |  | Satellite Position at record start | 3 (x, y, z) | 64 bit float |
| 2 |  | Satellite Position at record end | 3 (x, y, z) | 64 bit float |
| 3 |  | Satellite Velocity at record start | 3 (x, y, z) | 64 bit float |
| 4 |  | Satellite Velocity at record end | 3 (x, y, z) | 64 bit float |
| 5 |  | Colatitude of Subsatellite Point at Surface at record start | 1 | 32 bit float |
| 6 |  | Longitude of Subsatellite Point at Surface at record start | 1 | 32 bit float |
| 7 |  | Colatitude of Subsatellite Point at Surface at record end | 1 | 32 bit float |
| 8 |  | Longitude of Subsatellite Point at Surface at record end | 1 | 32 bit float |
| 9 |  | Earth-Sun Distance | 1 | 64 bit float |
| 10 |  | Colatitude of Subsolar Point at Surface | 1 | 32 bit float |
| 11 |  | Longitude of Subsolar Point at Surface | 1 | 32 bit float |
| 12 |  | Earth-Moon Distance | 1 | 32 bit float |
| 13 |  | Colatitude of Sublunar Point at Surface | 1 | 32 bit float |
| 14 |  | Longitude of Sublunar Point at Surface | 1 | 32 bit float |
| 15 |  | Solar Beta Angle at record start | 1 | 32 bit float |
| 16 |  | Solar Eta Angle at record start | 1 | 32 bit float |
| 17 |  | Lunar Beta Angle at record start | 1 | 32 bit float |
| 18 |  | Lunar Eta Angle at record start | 1 | 32 bit float |
| Record Size (bytes) | | | | 156 |

#### Temperature Counts

BDS Product Types: BDS, BDSS, BDSD, BDSM, BDSG, BDSP, BDSI

This data set contains the raw count values for instrument temperature parameters, copied from the Level-0 input data files. The data descriptions apply to both the Temperature Counts () parameters and the Converted Temperatures listed in . The Link column is hyperlinked from the tables to the parameter definition.

| Table ‑. Temperature Counts Field Summary | | | | |
| --- | --- | --- | --- | --- |
| Link | Field  Num | Parameter Name | Order | Data Type |
|  | 1 | Total Channel Heater DAC Value | 12 | Unsigned 16 bit integer |
|  | 2 | SW Channel Heater DAC Value | 12 | Unsigned 16 bit integer |
|  | 3 | WN Channel Heater DAC Value | 12 | Unsigned 16 bit integer |
|  | 4 | Blackbody Heater DAC Value | 12 | Unsigned 16 bit integer |
|  | 5 | TOT Detector Control Temperature | 12 | Unsigned 16 bit integer |
|  | 6 | TOT Detector Monitor Temperature | 12 | Unsigned 16 bit integer |
|  | 7 | SW Detector Control Temperature | 12 | Unsigned 16 bit integer |
|  | 8 | SW Detector Monitor Temperature | 12 | Unsigned 16 bit integer |
|  | 9 | WN Detector Control Temperature | 12 | Unsigned 16 bit integer |
|  | 10 | WN Detector Monitor Temperature | 12 | Unsigned 16 bit integer |
|  | 11 | TOT Blackbody Temperature | 12 | Unsigned 16 bit integer |
|  | 12 | WN Blackbody Temperature | 12 | Unsigned 16 bit integer |
|  | 13 | Elevation Spindle Temperature-Motor | 3 | Unsigned 16 bit integer |
|  | 14 | Elevation Spindle Temperature-CW | 3 | Unsigned 16 bit integer |
|  | 15 | Elevation Bearing Temperature-Motor | 3 | Unsigned 16 bit integer |
|  | 16 | Elevation Bearing Temperature-CW | 3 | Unsigned 16 bit integer |
|  | 17 | SWICS Photodiode Temperature | 3 | Unsigned 16 bit integer |
|  | 18 | Sensor Module Temperature | 3 | Unsigned 16 bit integer |
|  | 19 | Sensor Electronics Temperature | 3 | Unsigned 16 bit integer |
|  | 20 | Main Cover Motor Temperature | 3 | Unsigned 16 bit integer |
|  | 21 | MAM Total Baffle Temperature 1 | 3 | Unsigned 16 bit integer |
|  | 22 | MAM Total Baffle Temperature 2 | 3 | Unsigned 16 bit integer |
|  | 23 | MAM Assembly SW Temperature | 3 | Unsigned 16 bit integer |
|  | 24 | MAM Assembly Total Temperature | 3 | Unsigned 16 bit integer |
|  | 25 | DAA Radiator Temperature | 3 | Unsigned 16 bit integer |
|  | 26 | DAA Processor Electronics Temperature | 3 | Unsigned 16 bit integer |
|  | 27 | DAA ADC Electronics Temperature | 3 | Unsigned 16 bit integer |
|  | 28 | ECA Radiator Temperature | 3 | Unsigned 16 bit integer |
|  | 29 | ECA Electronics Temperature | 3 | Unsigned 16 bit integer |
|  | 30 | ACA Electronics Temperature | 3 | Unsigned 16 bit integer |
|  | 31 | Azimuth Lower Bearing Temperature | 3 | Unsigned 16 bit integer |
|  | 32 | Azimuth Upper Bearing Temperature | 3 | Unsigned 16 bit integer |
|  | 33 | ICA Radiator Temperature | 3 | Unsigned 16 bit integer |
|  | 34 | ICA Processor Electronics Temperature | 3 | Unsigned 16 bit integer |
|  | 35 | ICA ADC Electronics Temperature | 3 | Unsigned 16 bit integer |
|  | 36 | PCA Radiator Temperature | 3 | Unsigned 16 bit integer |
|  | 37 | PCA Electronics Temperature | 3 | Unsigned 16 bit integer |
|  | 38 | Pedestal Temperature 1-Brake Housing | 3 | Unsigned 16 bit integer |
|  | 39 | Pedestal Temperature 2-Isolator | 3 | Unsigned 16 bit integer |
|  | Record Size (bytes) | | |  |

#### Voltage - Torque Counts

BDS Product Type: BDS, BDSS, BDSD, BDSM, BDSG, BDSP, BDSI

This data set contains the raw count values for instrument voltage, current, and gimbal torque parameters, copied from the Level-0 input data files. The data descriptions linked from this table also apply to the Converted Voltages and Torques listed in .

| Table ‑. Voltage - Torque Counts Field Summary | | | | |
| --- | --- | --- | --- | --- |
| Link | Field  Num | Parameter Name | Order | Data Type |
|  | 1 | Detector +120V Bias | 3 | Unsigned 16 bit integer |
|  | 2 | Detector -120V Bias | 3 | Unsigned 16 bit integer |
|  | 3 | SWICS Photodiode Output | 3 | Unsigned 16 bit integer |
|  | 4 | SWICS Lamp Current | 3 | Unsigned 16 bit integer |
|  | 5 | ICA +5V Digital | 3 | Unsigned 16 bit integer |
|  | 6 | ICA +15V to ECA/ACA | 3 | Unsigned 16 bit integer |
|  | 7 | ICA -15V to ECA/ACA | 3 | Unsigned 16 bit integer |
|  | 8 | ICA + 5V Analog | 3 | Unsigned 16 bit integer |
|  | 9 | ICA +10V Bias | 3 | Unsigned 16 bit integer |
|  | 10 | ICA +15V Internal | 3 | Unsigned 16 bit integer |
|  | 11 | ICA -15V Internal | 3 | Unsigned 16 bit integer |
|  | 12 | DAA Ground Reference 1 | 3 | Unsigned 16 bit integer |
|  | 13 | DAA Ground Reference 2 | 3 | Unsigned 16 bit integer |
|  | 14 | DAA -10V Reference | 3 | Unsigned 16 bit integer |
|  | 15 | DAA +130V | 3 | Unsigned 16 bit integer |
|  | 16 | DAA -130V | 3 | Unsigned 16 bit integer |
|  | 17 | DAA +12V | 3 | Unsigned 16 bit integer |
|  | 18 | DAA -12V | 3 | Unsigned 16 bit integer |
|  | 19 | DAA +15V | 3 | Unsigned 16 bit integer |
|  | 20 | DAA -15V | 3 | Unsigned 16 bit integer |
|  | 21 | DAA +5V | 3 | Unsigned 16 bit integer |
|  | 22 | DAA +10V Reference | 3 | Unsigned 16 bit integer |
|  | 23 | ECA Torque Output | 12 | Unsigned 16 bit integer |
|  | 24 | ACA Torque Output | 12 | Unsigned 16 bit integer |
|  | Record Size (bytes) | | | 180 |

# Theory of Measurements and Data Manipulations

## Theory of Measurements

See Reference for the basic theory of measurements.

## Data Processing Sequence

The Instrument Subsystem (1.0) produces validated Level-1b geolocated radiance data from the raw Level-0 CERES instrument data. It reads and processes all science, calibration, and diagnostic data packets produced by CERES instruments on both the TRMM, EOS, and JPSS platforms. The BDS data products are produced via the following processing sequence:

1. Level-0, Ephemeris, and Attitude data are ingested into the ASDC. The data for the TRMM spacecraft come from the Sensor Data Processing Facility (SDPF) and the data for the Terra/Aqua come from the EOS Data Operations System (EDOS). The S-NPP data comes from NOAA’s Science Data Segment (SDS).
2. The Ephemeris and Attitude data are preprocessed through DPREP (an EOSDIS Core System (ECS) program to format the data into a SDP ToolKit readable format). S-NPP data are in Raw Data Record (RDR) and are preprossed using a Instrument Subsystem to convert the data into Level-0 format.
3. The Geolocate and Calibrate Earth Radiances Level-0 data processing software then:
4. Reads the Level-0, Ephemeris, and Attitude data.
5. Converts the raw instrument data to engineering units.
6. Using the converted instrument data, convert the radiances from raw digital counts to filtered radiance values.
7. Geolocate each radiance measurement at both the Earth’s surface and at the TOA (See ) in geodetic and geocentric coordinates, along with the corresponding calculated viewing angles.
8. Finally, output the data products and QC reports.

For additional detailed information, see the Subsystem Architectural Design Document (Reference ).

## Special Corrections/Adjustments

The following processing sequences and algorithms either expand on information discussed in ATBD 1.0 (Reference ) or have not been documented elsewhere.

### Raw Sensor Count to Filtered Radiance Conversion Sequence

Based on vicarious analyzes of the Terra and Aqua mission radiance data, the process of converting raw sensor counts to filtered radiances has been modified and refined beyond what is described in the ATBD 1.0 (Reference ). illustrates the original processing sequence used for the TRMM data and early Terra, Aqua, and S-NPP data.

\* Applied to Terra, Aqua, and S-NPP data only.

Raw

Counts

Adjust

for DAC

Updates

Convert

Counts to

Radiances

Remove Scan

Dependent

Offsets

Filtered

Radiances

3-Channel

InterCompare

Filter

\*

Single Scan

Drift

Correction

Apply 2nd

TC Filter

to Radiances

Calculate

Zero Refs.

Figure ‑. Original Counts to Radiance Processing Flow

The science data, count-to-radiance conversion algorithm quality is improved further by including corrections for the following effects:

* Bolometer sensor sensitivity, time dependent gain effects.
* Spurious slow mode (second time constant) effects across multiple scans, resulting in performing two drift correction steps on sensor counts.
* Tests for raw bit flips, and saturated or zeroed counts.
* Window channel SW corrections.

In addition to the sensor sensitivity effects, there is an associated sensor absorptivity, time dependent spectral coloration (wavelength) response effect. This effect is accounted for within theSpectral Unfiltering process within the ERBE-like Inversion to Instantaneous TOA Fluxes Subsystem (SS 2.0).

These adjustments on the modified count to radiances conversion sequence are illustrated in . The shadowed or earmarked boxes identifies additional or modified corrections. These sequence steps are described as follows:



Figure ‑. Counts to Radiance Processing Flow

1. Filter out saturated, zeroed,
2. Calculate and edit check the zero reference (space clamp) values for the current and the next scan counts.
3. Adjust for DAC update events in current and next scan counts.
4. Apply Single Scan Drift Correction to current scan counts.
5. Filter out 3-channel inter-comparison count faults in current scan.
6. Remove scan dependent offsets in current scan counts.
7. Apply second time constant filter algorithm to current scan counts (previously done on radiances).

Next perform single scan drift correction process a second time on counts by repeating steps 1 though 6.

1. Compute time dependent Gain drift correction factor.
2. Convert doubly drift corrected current scan counts into radiances and perform edit limit checks.
3. Apply SW correction to current scan WN channel radiances.

### Time Dependent Gain Correction.

Based on the results from the internal calibration analyses, the bolometer sensitivity has changed during mission lifetime as well as shifting from ground to flight. This is illustrated in below.



Figure ‑. Sensor Gain Drift

To accommodate these changes, the count-to-radiance conversion algorithm uses an adjusted gain coefficient. The adjustment is derived by linearly interpolating between specified gain coefficent values that correspond to specific update intervals. These intervals and the associated gain values are computed in off-line analyzese and are input to the production code as external files.

### Spaceclamp and DAC Update Adjustment Algorithm

The spaceclamp algorithm is designed to compensate for the effects of drift in the space reference measurements during the time interval of a single scan. This is accomplished by using the component of the radiometric count conversion equation (See Section 1.3.3, Reference ) represented as:

where:

= the sample (time) of a specific detector measurement within the scan.

= the sample (time) in the current scan that corresponds to the middle of the spacelook sample region used to compute a spaceclamp average.

= the sample (time) in the next contiguous scan that corresponds to the middle of the spacelook regions used to compute the spaceclamp average.

= the scan duration, corresponding to 660 samples (6.6 seconds).

= is the average detector output (in counts) within the current scan of a set of measurements corresponding to spacelooks.

= is the average detector output (in counts) within the next contiguous scan of a set of measurements corresponding to spacelooks.

= a gain coefficient.

The implementation of the spaceclamp algorithm requires first identifying which spacelook measurements to use for averaging and then "normalizing" the average to the beginning of the scan. The measurements used for averaging are from the first space look region of the elevation profile (See ). For the PFM instrument normal-earth scan profile, the number of spacelook views correspond to samples 0 .. 39, samples 0 .. 49 for the FM 1 - FM 4, and samples 0 .. 52 for the FM 5 instruments. It would be statistically desirable to include all of these measurements within the region. However, to allow for the spurious slow mode effects (See Section ), only the last 13 space measurements prior to detection of movement of the elevation assembly. For the PFM instrument, this corresponds to samples 27 .. 39, samples 37 .. 49 the FM 1 - FM 4, and samples 40 .. 52 for the FM 5 instruments. To "normalize" the spacelook average to the beginning of the scan, the variable is set to a sample number corresponding to the midpoint of the sample range used in the averaging process. For the PFM instrument, corresponds to sample number 33, sample number 43 for the FM 1 - FM 4, and sample 45 for the FM 5 instruments.

To illustrate how this algorithm works, the following is an example using the PFM scan profile in which the current scan contains a DAC update as shown in and . The middle sample of the region 27 .. 39 sets and to sample 33 (i.e., 39 - 27 + 1). Then becomes:

The scans from which and are taken must be contiguous in time for the algorithm to work. If the scans are not consecutive and contiguous in time, or DAC resets occurred, or the Moon is in the spacelook FOV, then radiometric count conversions are invalidated for the measurements taken within the scan in question. In addition, for the spaceclamp algorithm to function correctly, compensation for bridge balance DAC updates must be made. This is accomplished by an generating a suitable via an extrapolation process currently used in the subsystem. This extrapolation uses the difference between an average of count values before and after the bridge balance update. This is illustrated in by *DAC1* and *DAC0*. Typically, *DAC0* will be an average of values corresponding to samples 639 .. 643 and *DAC1* will be an average of values corresponding to samples 654 .. 659.



Figure ‑. Typical Raw Instrument Signal



Figure ‑. PFM Bridge Balance DAC Update Details

In addition, to ensure only quality spaceclamp values are used in radiance calculations, various statistical edit checks are performed. The results of these tests are identified in the Ancillary QA Flags Set 2 (Spaceclamp Algorithm) (See ) TOT/SW/WN SpaceClamp Status (See ). These results are based on the order that the quality edit and validation tests are performed. Since the spaceclamp algorithm requires two scans, tests are performed first on the current scan being processed, then on the next scan, then on the multi-scan extrapolation processes. This sequence and the resultant flag value is illustrated in .

| Table ‑. Spaceclamp Validation Order | | |
| --- | --- | --- |
| Scan | Flag (as coded) | Test Algorithm |
| Current | Too\_few\_samples | Too few values |
| Current | Moon\_Check\_Error | Toolkit error with moon ephemeris |
| Current | Moon\_in\_FOV | Moon in spacelook FOV |
| Current | Invalid\_Zero\_Reference | Spacelook values > standard deviation |
| Next | No\_2nd\_Value | Contiguous Scans |
| Next | No\_2nd\_Value | Too few values |
| Next | No\_2nd\_Value | Toolkit error with moon ephemeris |
| Next | No\_2nd\_Value | Moon in spacelook FOV |
| Next | No\_2nd\_Value | Spacelook values > standard deviation |
| Both | DAC\_Reset | Reset occurrence in current scan |
| Both | Unrecoverable\_DAC\_Update | DAC updated occurred, but can’t adjust due to:  (a) number samples before/after update unusable, or  (b) average value before update too low (e.g. <10) |
| Both | Adjusted\_DAC\_Update | Spaceclamp algorithm to use modified values. |
| Both | DAC Setpoint Changed | Invalid spaceclamp algorithm |
| Both | Limit\_Error | Spaceclamp(N)-Spaceclamp(N+1) > Threshold |
| (1)Error typically occurs when ephemeris data cannot be used to for moon view checks; all radiances are set to fill.  (2)No\_2nd\_Value is set within the current scan being processed. When scan N+1 is processed as a current scan, then the QA flags will be set appropriately.  (3)This test really should be done first and may be implemented in later software versions. Currently, a DAC reset will "appear" as either an invalid\_zero\_reference (for current scan) or as a no\_2nd\_value (for next scan). | | |

### Spurious Slow Mode Compensation

As a result of the bolometer design, there is a spurious slow mode effect seen in the radiometric measurements. The spurious slow mode is essentially a small but measurable second order delay in the response time of the detectors. This effect is also known as a "second time constant" effect and needs to be removed from the filtered radiance values. The Instrument Subsystem implements a compensating function that conforms to the requirements of the numerical filtering algorithm specified by Dr. Smith (Reference , Reference ). Note, beginning with CC 027205 BDS products, this compensation algorithm is applied on radiance counts instead of the converted filtered radiances. Additional details regarding the derivation of the compensation algorithm is discussed in :. This algorithm is implemented recursively by the following series of equations, (letting ):

Where:

is the representative slow mode response, and the two coefficients are described by the following:

Where:

 = slow mode time constant

c = modal amplitude factor

*k* = current sample being converted

*k-1* = previous consecutive sample

The term is the slow mode correction factor that was recursively calculated from the previous sample. However, if there is an invalid previous sample (due to time gap or invalid radiance value), then the previous value of used in the adjustment is assumed to be:

Calibration data are used to derive the values for  and c, and the values used in the data production system are listed in .

| Table ‑. Slow Mode Coefficients (; c) | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| Instrument | Detector Channel | | | | | |
| Total | | Window | | Shortwave | |
|  | *c* |  | *c* |  | *c* |
| PFM | 4.086 | 0.016 | 4.176 | 0.013 | 8.407 | 0.013 |
| FM 1 | 7.60 | 0.008 | 2.00 | 0.010 | 2.00 | 0.012 |
| FM 2 | 9.00 | 0.026 | 4.20 | 0.007 | 8.80 | 0.015 |
| FM 3 | 2.08 | 0.007 | 1.73 | 0.010 | 1.74 | 0.014 |
| FM 4 | 2.99 | 0.005 | 2.32 | 0.006 | 2.54 | 0.012 |
| FM 5 | 3.40 | 0.014 | 2.80 | 0.013 | 9.80 | 0.034 |

### Point Spread Function (PSF) lag algorithm

Radiant energy, when seen through the optical aperture of a scanning instrument, can be characterized as a point spread function, similar to a Gaussian distribution. When this energy is sampled by the bolometer sensor, there is a delay from the time the energy is incident on the sensor to the time it is actually sampled. When the sensor is moving relative to the target scene, this sampling delay causes the determination of the energy’s PSF (See ) centroid to lag behind the instantaneous FOV (See ) optical axis. The faster the motion, the more the centroid lags behind the optical center. This is not true in time, but is true in angle. Lag is caused by the sensor response time and not in scan motion.

For science analysis, the geolocation of an energy measurement requires that the PSF centroid be used for location and for not the sensor optical axis. However, since the FOV pointing geolocation process begins by using the elevation gimbal position referenced to this boresight, this time lag can be expressed in angular degrees. This lag has been determined by the Science Team and is currently specified as 1.56 degrees for the nominal Earth viewing elevation scanning rate. For the "rapid retrace" portion of the short-earth elevation scan profile, the angular PSF lag is proportionately increased by the ratio of the fast scan rate to the nominal rate. This correction corresponds to 6.17 degrees.

The PSF elevation angular position (in degrees) for any given sample is calculated using the following algorithm:

PSF\_Position = Gimbal\_Position - (Direction\_Factor\*LagScan\_Rate)

where:

Gimbal\_Position = Current elevation angular position (in degrees)

Direction\_Factor = (+1) for "forward" increasing scan gimbal angles or

(-1) for "backward" decreasing scan gimbal angles

LagScan\_Rate = Lag value as a function of the elevation scan rate (0.0o for no motion), currently identified in :

Table ‑. Applied PSF Lag Angle (Degrees)

|  |  |  |
| --- | --- | --- |
| Instrument | Normal Scan Rate | Elevated Scan Rate |
| PFM | 1.560° | 6.170° |
| FM 1 | 1.540° | 6.090° |
| FM 2 | 1.530° | 6.050° |
| FM 3 | 1.573° | 6.221° |
| FM 4 | 1.598° | 6.319° |
| FM 5 | 1.522° | 6.015o |

The determination of which LagScan\_Rate to use is derived using the following logic: compute the elevation angle difference between the current and previous sample and divide by 0.01 seconds to get an instantaneous scan rate. Then categorize this rate into one of the three conditions: no motion (e.g., spacelooks), a nominal scan rate, or an elevated scan rate.

### Channel intercomparison tests

Objective of this intercomparison is to catch possible inter-channel, electronic crosstalk influences. The technique to identify possible influenes uses the following combinatorial equation.

Where:

= a computed three-channel reference value, in counts.

= radiance count value for each corresponding three channel

= an emprically derived slope value for a corresponding radiance channel

= an emprically intercept value for a corresponding radiance channel

The computed value is checked against an empirically derived threshold. If it is greater than the threshold, the initial assumption of crosstalk is inferred. However, sun glint conditions have been found to cause this comparison to fail. A check of the FOV geometry is performed by

evaluating the Relative Azimuth (RAZ), Solar Zenith (SZ), and the Viewing Zenith (VZ) against minimum threshold angles. (See ) Equations used are:

If both and are less than their thresholds, a sun glint is assumed. However, if this last condition is not the case, then crosstalk bit flip conditions are assumed. The coefficients and threshold values utilized in these inter-comparison tests are shown in .

Table ‑. 3-Channel Inter-Comparison Coefficients

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Instrument | Detector Channel | | | | IC  Threshold | Zenith  Limit 1 | Zenith  Limit 2 |
| Window | | Shortwave | |
| Slope | Intercept | Slope | Intercept |
| PFM | 2.03 | 169.75 | 0.77 | -7.90 | 150.0 | 10.0 | 10.0 |
| FM 1 | 2.20 | 201.94 | 0.96 | -9.80 | 150.0 | 10.0 | 10.0 |
| FM 2 | 1.69 | 190.78 | 0.92 | -8.00 | 150.0 | 10.0 | 10.0 |
| FM 3 | 2.19 | 190.74 | 1.15 | -6.96 | 200.0 | 10.0 | 10.0 |
| FM 4 | 2.27 | 217.62 | 0.96 | -4.83 | 200.0 | 10.0 | 10.0 |
| FM 5 | 1.80 | 235.50 | 0.96 | -8.50 | 200.0 | 10.0 | 10.0 |

### Edit-limit and rate checks

To ensure the quality of the radiance and geolocation data, evaluation of instrument engineering (analog) and status (digital) parameters are performed. One of the ways this is accomplished is by using an edit limit comparison process that checks nominal expected values against predefined limit values. There are two comparison tests that are routinely performed: static edit limit tests and rate of change limit tests.

Static limit tests involve comparing most of the engineering parameter measurement values against predefined upper and lower limits. These limits are categorized into RED and YELLOW limits. YELLOW limit values typically represent conditions which can indicate possible degraded instrument performance or science data quality. RED limit values typically represent conditions where the instrument can be potentially damaged or where the science data quality is unacceptable. Most of the predefined limits are chosen based on mission operational health and safety requirements (e.g., Gimbal hitting hard stops), conditions that produce bad radiance or geolocation data (e.g., heatsink temperatures), and engineering and science experiences (e.g., ERBE).

Rate limit tests are used as a means of identifying greater than expected changes in values from one measurement to the next. Tests are useful for identifying possible glitches, transients, or shifts in the Instrument performance that could cause degraded science data quality. Rate tests are performed by taking the difference between two consecutive measurements and comparing

the difference to a predefined value. This step is repeated sequentially through the data. However, the first measurement in a packet is not compared to the last measurement in the previous packet. This setup is a fallout of the philosophy of assuming no prior knowledge about the state of the instrument from one packet to the next.

### Window Channel SW Correction

Due to intense SW scenic influences on Window channel measurements, the filter radiances need to be adjusted by using the following SW correction algorithm and logics:

If: SW Radiance > SW Tolerance Value

Then: WN\_Radiance = WN\_Radiance – Correction

Where:

Correction = SW\_Correction\_Factor \*(SW\_Radiance - SW\_Tolerance Value)

The values used in these equations are shown in .

Table ‑. Window Channel SW Correction Values

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| SW Variable  References | TRMM | Terra | | Aqua | | S-NPP |
| PFM | FM 1 | FM 2 | FM 3 | FM 4 | FM 5 |
| Tolerance | 200.0 | 200.0 | 200.0 | 185.0 | 150.0 | 200.0 |
| Correction Factor | 0.0 | 0.0024 | 0.0 | 0.004 | 0.0055 | 0.0 |

### Packet Time Stamp Errors

For the CERES instruments on both the Terra, Aqua, and S-NPP spacecraft, the time stamp fields can range from 0..1000 micro-seconds instead of the correct 0..999 micro-second range. Corrections are typically done by the EOSDIS level 0 data processor. However, the instrument subsystem can also detect and correct time stamp inconsistencies.

# Errors

The accuracy goal for calibrated filtered radiances is 1.0% for the shortwave, 0.3 Wm -2 sr-1 for the window, and 0.5% for the total channels for scene levels greater than 100 Wm -2 sr-1. For scene levels less than 100 Wm -2 sr-1, the goals are 0.8 Wm -2 sr-1, 0.3 Wm -2 sr-1, and 0.6 Wm -2 sr-1, respectively. The conversion equations, coefficients, offsets, and any correction adjustments are determined by the CERES Science Team and the instrument builder, TRW, based on pre-launch ground test data and initial in-orbit instrument checkout results. See Reference for a general discussion of error budgets.

## Quality Assessment

Quality Assessment (QA) activities are performed at the Science Computing Facility (SCF) by the Data Management and Science Teams. Processing reports containing statistics and processing results are examined for anomalies. If the reports show anomalies, data visualization tools are used to examine those products in greater detail to begin the anomaly investigation. See the QA flag descriptions for this product listed in , , and .

## Data Validation by Source

See Subsystem 1.0 Validation Document (Reference ) for details on data validation plans and see Reference and Reference for details on the geolocation coastline detection algorithm used to validate the geolocation parameters.

# Notes

Note-1 Flight (Orbital) Data Conversion

The conversion from monitor element resistances to engineering units for all instruments are governed by the following algorithms, as described in TRW DRL-64 (See Reference ).

**Algorithm 1** - The Platinum Resistance Thermometer (PRT) conversion equations for the blackbody total and window channels are:

where:

Table ‑. Algorithm 1 Blackbody Coefficients

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Instrument | Total Channel | | | Window Channel | | |
| C1 | C2 | C3 | C1 | C2 | C3 |
| PFM | 3358.45595 | 12981207.69 | 851.4909514 | 3358.904792 | 12984225.97 | 851.893192 |
| FM 1 | 3359.020854 | 12985004.09 | 852.822931 | 3356.751461 | 12969764.77 | 851.645879 |
| FM 2 | 3359.566235 | 12988668.66 | 852.0631807 | 3358.57417 | 12982001.30 | 851.6526198 |
| FM 3 | 3357.3836020 | 12974005.91 | 850.3719228 | 3360.087691 | 12992173.87 | 852.1320380 |
| FM 4 | 3358.1494940 | 12979149.29 | 851.1928459 | 3359.23329 | 12986431.13 | 853.2076076 |
| FM 5 | 3360.5260161 | 12995117.53 | 852.7158349 | 3359.2486219 | 12986533.26 | 851.7938292 |

**Algorithm 2** - The Sensor Control Temperature (SCT) conversion equations for the SW, TOT, and WN channels are:

where:

and the values of C, D, E, F, and G are shown in , , and for each of the radiometric channels.

Table ‑. Algorithm 2 Temperature Coefficients - Shortwave Channel

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Instrument | Shortwave Channel | | | | |
| C | D | E | F | G |
| PFM | 865.16 | 4.179167 | 275520.4 | 271.471234 | 2.10x10-4 |
| FM 1 | 868.62 | 4.5825 | 278009.6 | 269.021132 | 2.10x10-4 |
| FM 2 | 864.53 | 4.6158 | 277306.5 | 269.021132 | 2.10x10-4 |
| FM 3 | 859.82 | 4.5717 | 275520.4 | 269.021132 | 2x10-4 |
| FM 4 | 861.24 | 4.5625 | 275921.5 | 269.021132 | 2x10-4 |
| FM 5 | 862.27 | 4.5433 | 275921.5 | 269.021132 | 2x10-4 |

Table ‑. Algorithm 2 Temperature Coefficients - Total Channel

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Instrument | Total Channel | | | | |
| C | D | E | F | G |
| PFM | 860.85 | 4.5525 | 275520.4 | 269.021132 | 2x10-4 |
| FM 1 | 868.28 | 4.6017 | 278009.6 | 269.021132 | 2x10-4 |
| FM 2 | 866.10 | 4.5775 | 277306.5 | 269.021132 | 2x10-4 |
| FM 3 | 859.31 | 4.5883 | 275520.4 | 269.021132 | 2x10-4 |
| FM 4 | 859.94 | 4.5958 | 275921.5 | 269.021132 | 2x10-4 |
| FM 5 | 860.83 | 4.5875 | 275921.5 | 269.021132 | 2x10-4 |

Table ‑. Algorithm 2 Temperature Coefficients - Window Channel

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Instrument | Window Channel | | | | |
| C | D | E | F | G |
| PFM | 862.30 | 4.4925 | 275520.4 | 269.021132 | 2x10-4 |
| FM 1 | 868.61 | 4.5808 | 278009.6 | 269.021132 | 2x10-4 |
| FM 2 | 865.96 | 4.5741 | 277306.5 | 269.021132 | 2x10-4 |
| FM 3 | 859.78 | 4.5758 | 275520.4 | 269.021132 | 2x10-4 |
| FM 4 | 860.14 | 4.5925 | 275921.5 | 269.021132 | 2x10-4 |
| FM 5 | 860.85 | 4.5858 | 275921.5 | 269.021132 | 2x10-4 |

**Algorithm 3** - The Thermistor Temperature Conversion (TTC) equations for instrument parameters measured by thermistor monitors are:

where:

Algorithm 3A (Detector Monitors):

Algorithm 3B - (Sensor Electronics Assembly Thermistors):

Algorithm 3C - (General Temperature Monitors):

**Algorithm 4** - The Linear Conversion (LC) equation for instrument parameters is:

where:

Table ‑. Algorithm 4 Linear Coefficients

|  |  |  |  |
| --- | --- | --- | --- |
| Data Type | Slope (m) | Intercept (b) | Units |
| 4A | 0.004884 | 0 | Volts |
| 4B | 0.005861 | -20 | Volts |
| 4C | 0.060048 | 0 | Volts |
| 4D | 0.003995 | -135.819 | Volts |
| 4E | 0.002442 | 115.001 | Volts |
| 4F | 0.002442 | -125.000 | Volts |
| 4G | 0.003907 | 0.0 | Volts |
| 4H | 0.046617 | -95.712 | in-oz. |
| 4I | 0.129861 | -266.625 | in-oz. |
| 4J | 0.0019536 | 0 | Volts |
| 4K | 0.0054932 | 0 | Degrees |
| 4L | 0.028145 | 0 | mA |
| 4M | 6.6 | 0 | sec |
| 4N | 0.001 | 0 | msec |
| 4O | 0.00293 | 0 | Volts |

Note: Algorithm needs to be slightly modified to correct for an additional alignment bias uncovered during FM 1/2 ground testing. This equation becomes:

where the bias correction coefficient (c) is listed in .

Table ‑. Algorithm 4K Azimuth Gimbal Bias Coefficient (Counts)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| PFM | FM 1 | FM 2 | FM 3 | FM 4 | FM 5 |
| 0 | +27 | -18 | 0 | 0 | 0 |

**Algorithm 5** - Solar Aspect Sensor (N/A).

- Solar Presence Sensor (See ).

**Algorithm 7** - Gimbal Rate (in deg/sec):

**Algorithm 8** Sensor Response

A simplified conversion to filtered radiance(ΔL) based on component values is defined as follows:

where:

GE = Electronics gain (Volts/Volt)

RB = Detector Responsivity = R0\*VB/V0

VB = Actual bias voltage

V0 = Nominal bias voltage

R0 = Nominal responsivity

AΩ = Telescope Throughput (m2-sr)

**Note-2 CERES Point Spread Function**

Note-2.1 **CERES Point Spread Function**

The CERES scanning radiometer is an evolutionary development of the ERBE scanning radiometer. It is desired to increase the resolution as much as possible, using a thermistor bolometer as the detector. As the resolution is increased, the sampling rate must increase to achieve spatial coverage. When the sampling rate becomes comparable to the response time of the detector, the effect of the time response of the detector on the PSF must be considered. Also, the signal is usually filtered electronically prior to sampling in order to attenuate electronic noises and to remove high frequency components of the signal which would cause aliasing errors. The time response of the filter, together with that of the detector causes a lag in the output relative to the input radiance. This time lag causes the centroid of the PSF to be displaced from the centroid of the optical FOV. Thus, the signal as sampled comes not only from where the radiometer is pointed, but includes a “memory” of the input from where it had been looking. Another effect of the time response is to broaden the PSF, which will reduce the resolution of the measurement, increase blurring errors, and decrease aliasing errors.

Note-2.2 Geometry of the Point Spread Function

The scanner footprint geometry is given in . The optical FOV is a truncated diamond (or hexagon) and is 1.3° in the along-scan direction and 2.6° in the across-scan direction. The effective FOX (or footptint) is given by the PSF and is shown as an ellipse. A point within the footprint is located by β and δ. The cone angle  (or nadir angle) determines the location of the footprint centroid on the Earth. If  = 0, the footprint is at nadir. The viewing zenith angle θ is a direct result of the satellite altitude h, the Earth radius rE, and the cone angle . The surface distance ι and the Earth central angle γ between nadir and the centroid are also a result of the viewing geometry. In we have denoted the length of the FOV by ∆ι.



Figure 8‑1. Scanner Footprint Geometry

gives three CERES FOVs. The shaded area is the optical FOV. Note that only half of the FOV is given since it is symmetrical about the scan line. The origin has been placed at the centroid of the PSF which trails the optical axis by approximately 1.5 degree. This is the lag that is inherent in the system. About the PSF centroid, the outline has been drawn on the 95-percent energy boundary. An angular grid, also has been drawn over the 95% energy FOV for weighting cloud parameters in a later process. All of the pertinent dimensions are given.



Figure 8‑2. CERES Field-of-View Angular Grid

Note-2.3 Analytic form of the Point Spread Function

A full discussion of an analytic model of the point spread function, including the effects of the detector time response and Bessel filter, and its development are given in Smith (See Reference ). (Note, some of the following equations uses different variable symbols herein for clarity.

From , we redraw half of the optical FOV in where δ’ is the along-track scan angle and β is the cross-scan angle. Note that δ’ points opposite the scan direction and increases toward the tail of the PSF (See ). The forward and back boundaries are given by and , respectively.



Figure ‑. Optical FOV

With these definitions the CERES PSF response can be described as

|  |  |
| --- | --- |
|  | (1) |

where

|  |  |
| --- | --- |
|  | (2) |

with the coefficients are

where is in degrees, and are in radians. The centroid of the PSF is derived in Smith (See Reference )and is shifted 1.51o from the optical axis. This shift is denoted in and a new angle δ is defined relative to the centroid. To evaluate the PSF, determine δ and then set , where is the shift (or offset) from the optical axis to the centroid. This is accomplished by using a general form of , which incorporates the time domain effects of the detector time response, Bessel filter, and scan rate, and is given by

|  |  |
| --- | --- |
|  | (3) |

where

The relationship of the detector time response to the Bessel filter is

The 4-pole, linear phase Bessel filter is described by the transfer function complex roots

The system response for a step input to the Bessel filter is evaluated by using the method of residues which can be written as:

where the coefficients are

and the residues are

Note that , 𝜂, and are non-dimensional so that is in radians. The cone angle ξ has units of degrees. The complex variables , , then define the coefficients of equation as and as

The centroid of the PSF can be thus be derived from the analytic expression given by

|  |  |
| --- | --- |
|  | (4) |

The numerical values given in equation are based on the following prelaunch calibration constants:

Bessel Filter characteristic frequency (3db @ 22.21 Hz)

Scan rate

Detector first order time response with the corresponding angular shift δ values are shown in .

Table ‑. Detector Time Constant ( seconds, angular degrees)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Instrument | Detector Channel | | | | | |
| Total | | Window | | Shortwave | |
|  seconds | Degrees (\*) |  seconds | Degrees |  seconds | Degrees |
| PFM | 0.00860 | 1.556 | 0.00830 | 1.537 | 0.00815 | 1.527 |
| FM 1 | 0.00850 | 1.549 | 0.00795 | 1.515 | 0.00825 | 1.533 |
| FM 2 | 0.00800 | 1.518 | 0.00820 | 1.530 | 0.00820 | 1.530 |
| FM 3 | 0.008875 | 1.573 | 0.008675 | 1.560 | 0.008375 | 1.541 |
| FM 4 | 0.009275 | 1.598 | 0.008575 | 1.554 | 0.008875 | 1.573 |
| FM 5 | 0.009075 | 1.585 | 0.009075 | 1.516 | 0.007975 | 1.516 |
| (\*) These angles are used in the production processing code for all three channels. | | | | | | |

**Note-3 Field of View (FOV)**

Field-of-View and footprint are synonymous. The CERES FOV is determined by its PSF (See and ) which is a two-dimensional, bell-shaped function that defines the CERES instrument response to the viewed radiation field.

The resolution of the CERES radiometers is usually referenced to the optical FOV which is 1.3o in the along-track direction and 2.6o in the cross-track direction. For example, on TRMM with a satellite altitude of 350 km, the optical FOV at nadir is 8 ×km which is frequently referred to as an equivalent circle with a 10 km diameter, or simply as 10 km resolution. On Terra and Aqua with a satellite altitude of 705 km, the optical FOV at nadir is 16 × 32 km or 20 km resolution. On S-NPP with a satellite altitude of 824 km, the optical FOV at nadir is 18 x 36 or 22 km resolution.

The CERES FOV or footprint size is referenced to an oval area that represents approximately 95% of the PSF response (See and ) for numerical representation of FOV). Since the PSF is defined in angular space at the instrument, the CERES FOV is a constant in angular space, but grows in surface area from a minimum at nadir to a larger area at shallow viewing angles (See ). For TRMM, the length and width of this oval at nadir is 19 × 15 km and grows to 138 × 38 km at a viewing zenith angle (See ) of 70o. For Terra and Aqua, the length and width at nadir is 38 × 31 km and grows to 253 × 70 km at a viewing zenith angle of 70o. For S-NPP, the length and width at nadir is 40 × 33 km and grows to 266 × 74 km at a viewing zenith angle of 70o.

**Note-4 Conversion of Julian Date to Calendar Date**

The Julian Date is a time system that has been adopted by astronomers and is used in many scientific experiments. The Julian Date or Julian Day is the number of mean solar days since 1200 hours (GMT/UT/UTC/Zulu) on Monday, 24 November 4714 BCE, based on the current Gregorian calendar, or more precisely, the Gregorian Proleptic calendar. In other words, Julian day number 0 (zero) was Monday, 24 November 4714 Before Current Era (BCE), 1200 hours (noon). A new Julian day starts when the mean Sun at noon crosses the Greenwich meridian. This differs from Universal Time (UT) or Greenwich Mean Solar Time by 12 hours since UT changes day at Greenwich midnight. below provides Julian day numbers which relate Universal Time to Julian date.

Important facts related to the Gregorian calendar are:

1. There is no year zero; year -1 is immediately followed by year 1.
2. A leap year is any year which is divisible by 4, except for those centesimal years (years divisible by 100) which must also be divisible by 400 to be considered a leap year.
3. A leap year has 366 days, with the month of February containing 29 days.
4. Year -1 is defined as a leap year, thus being also defined as containing 366 days, and being divisible by 4, 100, and 400.

Information on history, calendars, and Julian day numbers can be found in Blackadar’s (Reference ) “A Computer Almanac”, and on the WWW (Reference ).

The Julian day whole number is followed by the fraction of the day that has elapsed since the preceding noon (1200 hours UTC). The Julian Date JDATE can be represented as:

JDATE = JDay + JFract

where:

JDay = the integer Julian Day number and

JFract = the “fractional” Julian day (0 to 0.99...9)

(e.g. 245\_0814.0 = 1200 or noon, 31 December, 1997 UT)

When the fractional part of the combined julian date is .0, it is noon or 1200 hours GMT and when the fraction part is .5, then it is midnight or 0000 hours GMT.

The calculation of GMT (YYYYMMDD-HH:MM:SS.SSS) from Julian date (JDATE) is performed using the following process.

1. The YYYYMMDD can be determined using to find the year and the beginning of the month whose Julian Day occurs before the JDay integer value.
2. Calculate the number of days past the 0.5 day of the month via which provides Julian day numbers which relate Universal Time to Julian date.

The GMT is determined by first computing the number of seconds in the day since midnight:

if JFract > 0.5,

then Seconds = 86400.0 \* (JFract-0.5)

if JFract <= 0.5,

then Seconds = 86400.0 \* (JFract+0.5)

Then compute HH, MM, and SS where:

HH = Int(Seconds/3600)

MM = Int(Seconds-(HH\*3600.0)/60)

SS = Seconds-(HH\*60.0 + MM)\*60.0

As an example, if JD = 244\_5733.5833, then the GMT date is computed using by finding the closest beginning monthly calendar noon date, which is Feb 0.5, 1984 (UT).

(Feb 0.5) Jday

244\_5731 < 244\_5733.5833

JD = 244\_5733.5833 is 2.5833 days past Feb 0.5, 1984 UT (i.e., past 1984 Jan 31d 12h 0m 0s)  
 where 1984 Jan 31d 12h 0m 0ss = (244\_5733-244\_5731).

Beginning with the whole days portion of 2.5833 (i.e., 2), the GMT Date is   
 1984 Jan 31d 12h 0m 0s + 2 = 1984 Feb 2d 12h 0m 0s.

Next, since JFract (0.5833) is > 0.5, 12h is added to the GMT Date, yielding:   
 1984 Feb 2d 12h 0m 0s + 12h 0m 0s = 1984 Feb 3d 0h 0m 0s.

Finally, to get the GMT time and since JFract (0.5833) is > 0.5, the number of seconds =  
 86400 \*(0.5833 -0.5) = 7197.12 yielding:

HH = 7197.12 / 3600 = 01.9992 = 01h

MM = 7197.12 - ((1\*3600) / 60) = 59.952 = 59m

SS = 7197.12 - ((1\*60) + 59)\*60) = 57.12s

Therefore, the GMT Date corresponding to the Julian Date 244\_5733.5833 =   
 1984 Feb 3d 1h 59m 57.12s, which is UT = 1984 Jan 31d 12h 0m 0s + 2.5833 days.

Table ‑. Julian Day Number

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Year | Jan  0.5a | Feb 0.5 | Mar. 0.5 | Apr. 0.5 | May 0.5 | June 0.5 | July 0.5 | Aug 0.5 | Sept 0.5 | Oct 0.5 | Nov 0.5 | Dec 0.5 |
| 1980t | 244\_4239 | \_4270 | \_4299 | \_4330 | \_4360 | \_4391 | \_4421 | \_4452 | \_4483 | \_4513 | \_4544 | \_4574 |
| 1981 | \_4605 | \_4636 | \_4664 | \_4695 | \_4725 | \_4756 | \_4786 | \_4817 | \_4848 | \_4878 | \_4909 | \_4939 |
| 1982 | \_4970 | \_5001 | \_5029 | \_5060 | \_5090 | \_5121 | \_5151 | \_5182 | \_5213 | \_5243 | \_5274 | \_5304 |
| 1983 | \_5335 | \_5366 | \_5394 | \_5425 | \_5455 | \_5486 | \_5516 | \_5547 | \_5578 | \_5608 | \_5639 | \_5669 |
| 1984t | \_5700 | \_5731 | \_5760 | \_5791 | \_5821 | \_5852 | \_5882 | \_5913 | \_5944 | \_5974 | \_6005 | \_6035 |
| 1985 | 244\_6066 | \_6097 | \_6125 | \_6156 | \_6186 | \_6217 | \_6247 | \_6278 | \_6309 | \_6339 | \_6370 | \_6400 |
| 1986 | \_6431 | \_6462 | \_6490 | \_6521 | \_6551 | \_6582 | \_6612 | \_6643 | \_6674 | \_6704 | \_6735 | \_6765 |
| 1987 | \_6796 | \_6827 | \_6855 | \_6886 | \_6916 | \_6947 | \_6977 | \_7008 | \_7039 | \_7069 | \_7100 | \_7130 |
| 1988t | \_7161 | \_7192 | \_7221 | \_7252 | \_7282 | \_7313 | \_7343 | \_7374 | \_7405 | \_7435 | \_7466 | \_7496 |
| 1989 | \_7527 | \_7558 | \_7586 | \_7617 | \_7647 | \_7678 | \_7708 | \_7739 | \_7770 | \_7800 | \_7831 | \_7861 |
| 1990 | 244\_7892 | \_7923 | \_7951 | \_7982 | \_8012 | \_8043 | \_8073 | \_8104 | \_8135 | \_8165 | \_8196 | \_8226 |
| 1991 | \_8257 | \_8288 | \_8316 | \_8347 | \_8377 | \_8408 | \_8438 | \_8469 | \_8500 | \_8530 | \_8561 | \_8591 |
| 1992t | \_8622 | \_8653 | \_8682 | \_8713 | \_8743 | \_8774 | \_8804 | \_8835 | \_8866 | \_8896 | \_8927 | \_8957 |
| 1993 | \_8988 | \_9019 | \_9047 | \_9078 | \_9108 | \_9139 | \_9169 | \_9200 | \_9231 | \_9261 | \_9292 | \_9322 |
| 1994 | \_9353 | \_9384 | \_9412 | \_9443 | \_9473 | \_9504 | \_9534 | \_9565 | \_9596 | \_9626 | \_9657 | \_9687 |
| 1995 | 244\_9718 | \_9749 | \_9777 | \_9808 | \_9838 | \_9869 | \_9899 | \_9930 | \_9961 | \_9991 | \*0022 | \*0052 |
| 1996t | 245\_0083 | \_0114 | \_0143 | \_0174 | \_0204 | \_0235 | \_0265 | \_0296 | \_0327 | \_0357 | \_0388 | \_0418 |
| 1997 | \_0449 | \_0480 | \_0508 | \_0539 | \_0569 | \_0600 | \_0630 | \_0661 | \_0692 | \_0722 | \_0753 | \_0783 |
| 1998 | \_0814 | \_0845 | \_0873 | \_0904 | \_0934 | \_0965 | \_0995 | \_1026 | \_1057 | \_1087 | \_1118 | \_1148 |
| 1999 | \_1179 | \_1210 | \_1238 | \_1269 | \_1299 | \_1330 | \_1360 | \_1391 | \_1422 | \_1452 | \_1483 | \_1513 |
| 2000t | 245\_1544 | \_1575 | \_1604 | \_1635 | \_1665 | \_1696 | \_1726 | \_1757 | \_1788 | \_1818 | \_1849 | \_1879 |
| 2001 | \_1910 | \_1941 | \_1969 | \_2000 | \_2030 | \_2061 | \_2091 | \_2122 | \_2153 | \_2183 | \_2214 | \_2244 |
| 2002 | \_2275 | \_2306 | \_2334 | \_2365 | \_2395 | \_2426 | \_2456 | \_2487 | \_2518 | \_2548 | \_2579 | \_2609 |
| 2003 | \_2640 | \_2671 | \_2699 | \_2730 | \_2760 | \_2791 | \_2821 | \_2852 | \_2883 | \_2913 | \_2944 | \_2974 |
| 2004t | 245\_3005 | \_3036 | \_3965 | \_3096 | \_3126 | \_3157 | \_3187 | \_3218 | \_3249 | \_3279 | \_3310 | \_3340 |
| 2005 | \_3371 | \_3402 | \_3430 | \_3461 | \_3491 | \_3522 | \_3552 | \_3583 | \_3614 | \_3644 | \_3675 | \_3705 |
| 2006 | \_3736 | \_3767 | \_3795 | \_3826 | \_3856 | \_3887 | \_3917 | \_3948 | \_3979 | \_4009 | \_4040 | \_4070 |
| 2007 | \_4101 | \_4132 | \_4160 | \_4191 | \_4221 | \_4252 | \_4282 | \_4313 | \_4344 | \_4374 | \_4405 | \_4435 |
| 2008t | 245\_4466 | \_4497 | \_4526 | \_4557 | \_4587 | \_4618 | \_4648 | \_5679 | \_4710 | \_4740 | \_4771 | \_4801 |
| 2009 | \_4832 | \_4863 | \_4891 | \_4922 | \_4952 | \_4983 | \_5013 | \_5044 | \_5075 | \_5105 | \_5136 | \_5166 |
| a Jan. 0.5 (UT) is the same as Greenwich noon (12h) UT, Dec. 31. \* These dates begin with 245 t Denotes leap years | | | | | | | | | | | | |

**N****ote-5 Solar and Lunar Calibration Raster Scanning**

The BDS science products continue to improve their accuracy based on vicarious calibration activities. CERES routinely peformed bi-weekly Solar calibrations that fixed the azimuth gimbal and used the elevation to scan between space and the MAM surface. The Sun tracked a nearly vertical slice through the MAM FOV window. Similarly, Lunar calibrations were routinely adopted around 2005.

As part of the validation process, calibration trends over time need to be maintained. This included evaluating bolometer inter-channel relative pointing accuracy, Point Spread Function, and a mapped spatial non-uniformities. MAM non-uniformity responsiviness needed to be mapped. To accomplish these objectives, CERES has modified the Solar and Lunar calibration on-orbit operations. Instead of fixing the azimuth gimbal and slewing the elevation gimbal, the processed is now reversed. At sunset (moonset), the elevation is set to a fixed angle (Solar calibration MAM view) or a set of fixed angles (Lunar calibration space/moon views). The azimuth is then slewed using an A-synchronous operation to allow the bolometers to see a swept, raster motion across the MAM or bolometer. This is illustrated in the lunar raster scan concept in . The Lunar viewing scan example can be seen in .

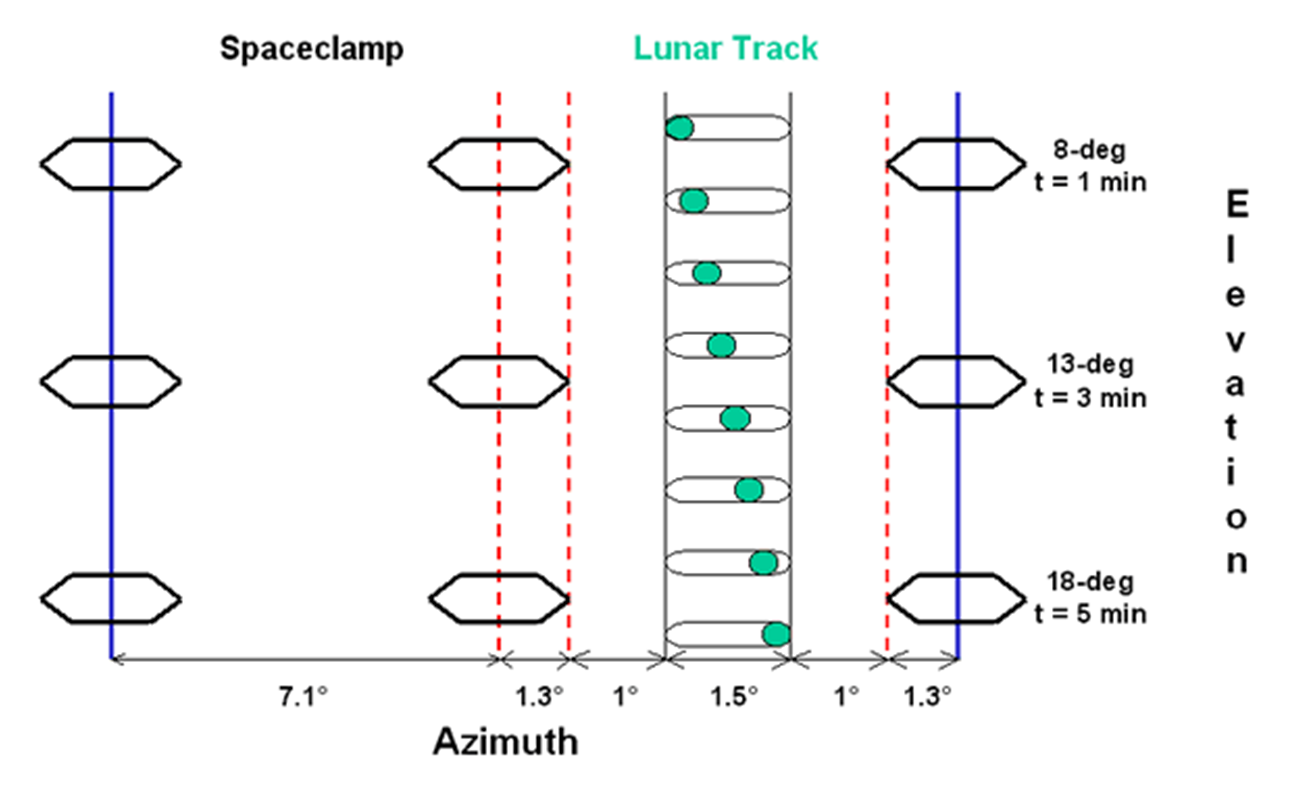


Figure ‑. CERES Calibration Raster Scanning Concept

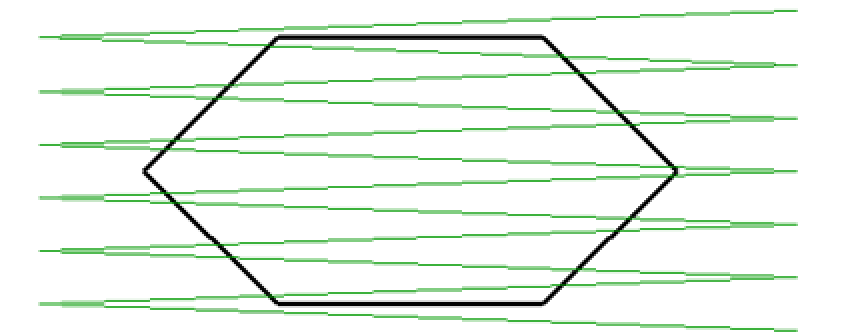


Figure ‑. CERES Calibration FOV Raster Scan

# Application of the Data Set

The BDS science product provides the instantaneous geolocated filtered radiances for the ERBE-like Subsystem 2.0. It is intended as the primary archival product for CERES Level-0 and Level-1B instantaneous science and engineering measurements.

# Future Modifications and Plans

Modifications to the BDS product are driven by radiometric validation results and any additional instrument or spacecraft related parameters. The ASDC provides users notification of changes.

# Software Description

There is a C read program that interfaces with the HDF libraries and a README file available from the LaRC ASDC User Services. The program was designed to run on a Unix workstation and can be compiled with a C compiler.

# Contact Data Center/Obtain Data

NASA Langley ASDC Telephone: (757) 864-8656

User and Data Service Office FAX: (757) 864-8807

NASA Langley Research Center E-mail: support-asdc@earthdata.nasa.gov

Mail Stop 157D URL: https://eosweb.larc.nasa.gov/

2 South Wright Street

Hampton, VA 23681-2199

USA

# Output Products and Availability

Several media types are supported by the Langley ASDC Web Order Tool. CERES data can be downloaded from the Web or via FTP. Alternatively, data can be ordered on media types. These currently include CD-ROM and Videocassettes.

Data ordered via the Web or via FTP can be downloaded in either Uncompressed mode or in UNIX Compressed mode. Data written to media tape (in either Uncompressed mode or in UNIX Compressed mode) is in UNIX TAR format.

Note that the availability of output products and the medium of access may change with the advancement of Information Technology.

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# Glossary of Terms

Term-1 CERES Point Spread Function (PSF)

A Point Spread Function (PSF) is a two-dimensional bell-shaped function that defines the CERES instrument response to the viewed radiation field. Due to the response time, the radiometer responds to a larger FOV than the optical FOV and the resulting PSF centroid lags the optical FOV centroid by more than a degree of cone angle (See ) for normal scan rates (See ).

Term-2 Count Conversion

Conversion from instrument counts to engineering units by a count conversion equation (See Reference ).

Term-3 Earth Equator, Greenwich Meridian System

The Earth equator, Greenwich meridian system is an Earth-fixed, geocentric, rotating coordinate system with the X-axis in the equatorial plane through the Greenwich meridian, the Y-axis lies in the equatorial plane 90o to the east of the X-axis, and the Z-axis is toward the North Pole.

Term-4 Earth Surface

The surface of the Earth as defined by the WGS-84 Earth Model. The WGS-84 model of the Earth surface is an ellipsoid where = 6378.1370 km and = 6356.7523 km (See ).

Term-5 Earth Point

The viewed point on the Earth surface (See ), or the point at which the PSF centroid intersects the Earth surface.

Term-6 Field of View

The terms Field of View (FOV) and footprint are synonymous (See ). The CERES FOV is determined by its PSF which is a two dimensional bell-shaped function that defines the CERES instrument response to the viewed radiation field.

The resolution of the CERES radiometers is usually referenced to the optical FOV and is 1.3o in the along-track direction and 2.6o in the cross-track direction. For TRMM with a satellite altitude of 350 km, the nadir optical FOV is 8 ×km which is frequently referred to as an equivalent circle with a 10 km diameter, or simply as 10 km resolution. For Terra and Aqua with a satellite altitude of 705 km, the optical FOV at nadir is 16 × 32 km or 20 km resolution. For S-NPP with a satellite altitude of 824 km, the optical FOV at nadir is 18 x 36 or 22 km resolution.

The CERES footprint size is referenced as an oval area representing ~95% of the PSF response (See ). Since the PSF is defined in instrument angular space, the CERES FOV is a constant in angular space, but grows in surface area from a minimum at nadir to a larger area at shallow viewing angles (See ). At nadir, this oval for TRMM is 19 × 15 km (Terra and Aqua is 38 × 31 km) and grows to 138 × 38 km (Terra and Aqua is 253 × 70 km) at a 70o viewing zenith angle. For S-NPP, the length and width at nadir is 40 × 33 km and grows to 266 × 74 km at a viewing zenith angle of 70o.

The ToolKit routine PGS\_CSC\_GetFOV\_Pixel returns the geodetic latitude and longitude of the intersection of the FOV centroid and the selected Model Surface. The returned longitudes are transformed from radians to degrees and then converted from ±180 to 0o .. 360o. The returned geodetic latitudes are transformed from radians to degrees and then converted to geodetic colatitude using (90.0-latitude).

Term-7 Geocentric Subsolar Point

The point on a surface where the geocentric zenith (See ) vector points toward the Sun (See ). This term is also applicable for the Geocentric Sublunar Point. (Substitute the Moon for the Sun.)

Term-8 Geocentric Zenith

A vector from the center of the Earth (See ) to the point of interest.

Term-9 Geodetic Subsolar Point

The point on a surface where the geodetic zenith (See ) vector points toward the Sun (See ). Although the geocentric latitude and the geodetic latitude are equal, the geocentric subsolar point is different from the geodetic subsolar point. Note that this term is applicable for the Geodetic Sublunar Point. (Substitute the Moon for the Sun.)

Geodetic

Subsolar

Point

X

Y

Z

a

b

d

c

Geodetic

Geocentric

Surface Tangent

Zenith

Sun (Moon)

Ellipsoid

Geocentric

Subsolar

Point

Zenith

Figure ‑. Subsolar Point

The ToolKit routine PGS\_CBP\_Earth\_CB\_vector calculates the Earth-Centered Inertial (ECI) position vector from the Earth to the Sun (Moon). A second ToolKit routine, PGS\_CSC\_ECItoECR, transforms the position vector to the ECR or Earth equator, Greenwich meridian rectangular coordinate system. From these coordinates, the geocentric colatitude and longitude of the Sun (Moon) are calculated.

Term-10 **Geodetic Zenith**

The vector normal to an ellipsoid (See ) at a point on the surface. At a point on the surface the geocentric latitude and the geodetic latitude are related by .

We can determine the radial distance r as a function of the geocentric latitude by setting and in the ellipsoidal model and solving for r yields:

.



Figure ‑. Ellipsoidal Earth Model

The semi-major axis (a) and the semi-minor axis (b) are defined by either the Earth Surface (See ) or the TOA (See ).

Term-11 Julian Date

A continuous count of time in whole and fractional days elapsed at the Greenwich meridian since noon on January 1, 4714 BCE. (See ).

Term-12 Subsatellite Point

The point on a surface below the satellite or the intersection point of a line dropped from the satellite through the surface (See ). The geocentric subsatellite point is on the radius vector to the center of the earth. The geodetic subsatellite point is on the geodetic zenith vector or the line dropped from the satellite is normal to the surface at the intersection point.



Figure ‑. Subsatellite Point

The ToolKit routine PGS\_CSC\_SubSatPoint returns the geodetic latitude and longitude of the subsatellite point. The returned longitudes are transformed from radians to degrees and then converted from ±180 to 0o × 360o. The returned latitudes are transformed from radians to degrees and then converted to colatitude using (90.0 - latitude).

Term-13 Target Point

The point at which the PSF (See ) centroid intersects the TOA (See ).

Term-14 **Top of the Atmosphere (TOA)**

The TOA is a surface approximately 30 km above the Earth surface (See ). Specifically, the TOA is an ellipsoid where = 6408.1370 km and = 6386.651 km (See ).

Term-15 **TOA Point**

The viewed point at the TOA, or the point at which the PSF centroid intersects the TOA (See ).

Term-16 **Solar Eclipse**

A solar eclipse is principally characterized when the angle,  between the Earth-Sun vector and the Earth-Moon vector is defined as . See . Additionally, consideration is required for instrument FOV measurements that can scan across the Moon’s shadow during orbital progression, for some conditions where . To identify these instances, an angle, θ is defined between the Satellite-Moon vector and the Satellite-Sun vector. This angle is also illustrated in . Based on an examination of 44 data months (Feb. 2000 - Sep. 2003, non-eclipse, ), orbital progression rates, and evaluation logic; a value θ=0.75° was selected for the production code. The logic for testing eclipse conditions is illustrated by . A first level check at the top of every hour is performed to see if the Moon may enter into an eclipse geometry sometime during the hour. A value is used to allow for progression margin. If this threshold occurs, then a second level check is performed once per packet scan for a threshold occurrence. This check is performed at the mid-packet time point. If this threshold occurs, it is assumed that all measurements within the packet are likely to be within a solar eclipse shadow. A third and final check verifies measurement’s FOV is pointing to the daytime orbit portion using SZA before setting the QA flag to eclipse.



Figure ‑. Solar Eclipse Angles Figure ‑. Solar Eclipse Logic

# List of Acronyms

APID Application Identifier

APD Aerosol Profile Data

ASDC Atmospheric Science Data Center

ATBD Algorithm Theoretical Basis Document

AVG Monthly Regional Radiative Fluxes and Clouds

BCE Before Current Era

BDS BiDirectional Scan (data product)

BDSD BiDirectional Scan - Diagnostic science (data product)

BDSF BiDirectional Scan - Fixed Pattern (data product)

BDSG BiDirectional Scan - Gimbal Error (data product)

BDSI BiDirectional Scan - Internal Calibration (data product)

BDSM BiDirectional Scan - Memory Dump (data product)

BDSP BiDirectional Scan - Processor Error (data product)

BDSS BiDirectional Scan - Solar Calibration (data product)

CC Configuration Code

CER CERES

CERES Clouds and the Earth’s Radiant Energy System

CID Cloud Imager Data (data product)

CRH Clear Reflectance History (data product)

CRS Clouds and Radiative Swath (data product)

CW Cable Wrap

DAAC Distributed Active Archive Center

DAC Digital to Analog Converter

DAP Data Acquisition microProcessor

DMA Direct Memory Access

DMS Data Management System

DRL Document Requirements List

ECR Earth-Centered Rotating

EDDB ERBE-Like Daily Database Product

EDOS EOS Data Operations System

EOS Earth Observing System

EOS-AM EOS Morning Crossing Mission (Terra)

EOS-PM EOS Afternoon Crossing Mission (Aqua)

EOSDIS Earth Observing System Data and Information System

ERBE Earth Radiation Budget Experiment

ERBS Earth Radiation Budget Satellite

FAPS Fixed Azimuth Plane Scan

FM Flight Model

FOV Field of View (See )

FSW Monthly Single Satellite Fluxes and Clouds

GAP Gridded Analysis Product

GB Gigabyte

GEO Geostationary Narrowband Radiances

GGEO Gridded Geostationary Narrowband Radiances

GOES Geostationary Operational Environmental Satellite

HDF Hierarchical Data Format

ICSBB Internal Calibration Source - Black Body

ICP Instrument Control microProcessor

IES Instrument Earth Scans (data product)

INSTR Instrument

JPSS Joint Polar Satellite System

LaRC Langley Research Center

LaTIS Langley TRMM Information System

MAM Mirror Attenuator Mosaic

MB Megabyte

MOA Meteorological, Ozone, and Aerosols (data product)

MODIS Moderate Resolution Imaging Spectrometer

MWH Microwave Humidity (data product)

NASA National Aeronautics and Space Administration

NOAA National Oceanic and Atmospheric Administration

NPOESS National Polar-orbiting Operational Environmental Satellite System

NPP NPOESS Preparatory Project

OPD Ozone Profile Data (data product)

PFM Prototype Flight Model (on TRMM)

PSA Product Specific Attribute

PSF Point Spread Function (See )

QA Quality Assessment

QC Quality Control

RAPS Rotating Azimuth Plane Scan

RDR Raw Data Record (for S-NPP)

SDS Scientific Data Set or NOAA’s Science Data Segment (for S-NPP)

SFC Hourly Gridded Single Satellite TOA/Surface Fluxes and Clouds (data product)

S-NPP Suomi NPOESS Preparatory Project

SPS Solar Presence Sensor

SRBAVG Surface Radiation Budget Average (data product)

SS Subsystem

SSF Single Satellite CERES Footprint TOA and Surface Fluxes, Clouds (data product)

SW Shortwave

SWICS Shortwave Internal Calibration Source

SYN Synoptic Radiative Fluxes and Clouds

TBD To Be Determined

TISA Time Interpolation and Spatial Averaging

TOA Top of the Atmosphere, Top of Atmosphere (See )

TOT Total

TRMM Tropical Rainfall Measuring Mission

URL Uniform Resource Locator

UT Universal Time

UTC Universal Time Code

VIRS Visible Infrared Scanner

WN Window

WWW World Wide Web

ZAVG Monthly Zonal and Global Average Radiative Fluxes and Clouds (data product)

Unit Definitions

|  |  |
| --- | --- |
| Units | Definition |
| AU | Astronomical Unit |
| C | centigrade, Celsius |
| cm | centimeter |
| count | count, counts |
| day | day, Julian date |
| deg | degree |
| deg sec-1 | degrees per second |
| DU | Dobson Unit |
| fraction | fraction 0..1 |
| g kg-1 | gram per kilogram |
| g m-2 | gram per square meter |
| hPa | hectoPascals |
| hour | hour |
| hhmmss | hour, minute, second |
| in-oz | inch-ounce |
| K | Kelvin |
| km | kilometer, kilometers |
| km sec-1 | kilometers per second |
| m | meter |
| m sec-1 | meter per second |
| micron | micrometer, micron |
| m | micrometer, micron |
| mA | milliamp, milliamps |
| msec | millisecond |
| mW cm-2 sr-1m-1 | milliWatts per square centimeter per steradian per micron |
| N/A | not applicable, none, unitless, dimensionless |
| % | percent, percentage 0..100 |
| rad | radian |
| sec | second |
| volt | volt, volts |
| W h m-2 | Watt hour per square meter |
| W m-2 | Watt per square meter |
| W m-2 sr-1 | Watt per square meter per steradian |
| W m-2 sr-1m-1 | Watt per square meter per steradian per micron |
| W | Watt, Watts |

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"These data were obtained from the NASA Langley Research Center Atmospheric Science Data Center."

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## Redistribution of Data

To assist the Langley ASDC in providing the best service to the scientific community, a notification is requested if these data are transmitted to other researchers.

## Document Curator

The Langley ASDC User & Data Services Office.

CERES Metadata

This section describes the metadata that are written to all CERES HDF products. describes the CERES Baseline Header Metadata that are written on both HDF and binary direct access output science data products. The parameters are written in HDF structures for CERES HDF output products and are written as 80-byte records for binary direct access output products. Some parameters may be written in multiple records. describes the CERES\_metadata Vdata parameters which are a subset of the CERES Baseline Header Metadata and are also written to all CERES HDF output products. For details on CERES Metadata, see the CERES Software Bulletin "CERES Metadata Requirements for LaTIS" (Reference ).

lists the item number, parameter name, units, range or allowable values, the data type, and the maximum number of elements. There are two choices for parameters 22-25 and two choices for parameters 26-29. The choices depend on whether the product is described by a bounding rectangle or by a G-Ring. Abbreviations used in the Data Type field are defined as follows:

s = string date = yyyy-mm-dd

F = float time = hh:mm:ss.xxxxxxZ

I = integer datetime = yyyy-mm-ddThh:mm:ss.xxxxxxZ

| Table ‑. CERES Baseline Header Metadata | | | | | |
| --- | --- | --- | --- | --- | --- |
| Item | Parameter Name | Units | Range | Data Type | No. of Elements |
| 1 | ShortName | N/A | N/A | s(8) | 1 |
| 2 | VersionID | N/A | 0 .. 255 | I3 | 1 |
| 3 | CERPGEName | N/A | N/A | s(20) | 1 |
| 4 | SamplingStrategy | N/A | CERES, TRMM-PFM-VIRS,  AM1-FM1-MODIS, TBD | s(20) | 1 |
| 5 | ProductionStrategy | N/A | Edition, Campaign, DiagnosticCase, PreFlight, TBD | s(20) | 1 |
| 6 | CERDataDateYear | N/A | 1997 .. 2050 | s(4) | 1 |
| 7 | CERDataDateMonth | N/A | 1 .. 12 | s(2) | 1 |
| 8 | CERDataDateDay | N/A | 1 .. 31 | s(2) | 1 |
| 9 | CERHrOfMonth | N/A | 1 .. 744 | s(3) | 1 |
| 10 | RangeBeginningDate | N/A | 1997-11-19 .. 2050-12-31 | date | 1 |
| 11 | RangeBeginningTime | N/A | 00:00:00.000000Z .. 24:00:00:000000Z | time | 1 |
| 12 | RangeEndingDate | N/A | 1997-11-19 .. 2050-12-31 | date | 1 |
| 13 | RangeEndingTime | N/A | 00:00:00.000000Z .. 24:00:00:000000Z | time | 1 |
| 14 | AssociatedPlatformShortName | N/A | TRMM, Terra, Aqua,  AM1, PM1, NPP, TBD | s(20) | 1 - 4 |
| 15 | AssociatedInstrumentShortName | N/A | PFM, FM1, FM2, FM3, FM4, FM5, TBD | s(20) | 1 - 4 |
| 16 | LocalGranuleID | N/A | N/A | s(80) | 1 |
| 17 | PGEVersion | N/A | N/A | s(10) | 1 |
| 18 | CERProductionDateTime | N/A | N/A | datetime | 1 |
| 19 | LocalVersionID | N/A | N/A | s(60) | 1 |
| 20 | ProductGenerationLOC | N/A | SGI\_xxx, TBD | s(255) | 1 |
| 21 | NumberofRecords | N/A | 1 .. 9 999 999 999 | I10 | 1 |
| 22 | WestBoundingCoordinate | deg | -180.0 .. 180.0 | F11.6 | 1 |
| 23 | NorthBoundingCoordinate | deg | -90.0 .. 90.0 | F11.6 | 1 |
| 24 | EastBoundingCoordinate | deg | -180.0 .. 180.0 | F11.6 | 1 |
| 25 | SouthBoundingCoordinate | deg | -90.0 .. 90.0 | F11.6 | 1 |
| 22 | GRingPointLatitude | deg | -90.0 .. 90.0 | F11.6 | 5 |
| 23 | GRingPointLongitude | deg | -180.0 .. 180.0 | F11.6 | 5 |
| 24 | GRingPointSequenceNo | N/A | 0 .. 99999 | I5 | 5 |
| 25 | ExclusionGRingFlag | N/A | Y (= YES), N (= NO) | s(1) | 1 |
| 26 | CERWestBoundingCoordinate | deg | 0.0 .. 360.0 | F11.6 | 1 |
| 27 | CERNorthBoundingCoordinate | deg | 0.0 .. 180.0 | F11.6 | 1 |
| 28 | CEREastBoundingCoordinate | deg | 0.0 .. 360.0 | F11.6 | 1 |
| 29 | CERSouthBoundingCoordinate | deg | 0.0 .. 180.0 | F11.6 | 1 |
| 26 | CERGRingPointLatitude | deg | 0.0 .. 180.0 | F11.6 | 5 |
| 27 | CERGRingPointLongitude | deg | 0.0 .. 360.0 | F11.6 | 5 |
| 28 | GRingPointSequenceNo | N/A | 0 .. 99999 | I5 | 5 |
| 29 | ExclusionGRingFlag | N/A | Y (= YES), N (= NO) | s(1) | 1 |
| 30 | AutomaticQualityFlag | N/A | Passed, Failed, or Suspect | s(64) | 1 |
| 31 | AutomaticQualityFlagExplanation | N/A | N/A | s(255) | 1 |
| 32 | QAGranuleFilename | N/A | N/A | s(255) | 1 |
| 33 | ValidationFilename | N/A | N/A | s(255) | 1 |
| 34 | ImagerShortName | N/A | VIRS, MODIS, TBD | s(20) | 1 |
| 35 | InputPointer | N/A | N/A | s(255) | 800 |
| 36 | NumberInputFiles | N/A | 1 .. 9999 | I4 | 1 |

describes the CERES\_metadata Vdata parameters which are written to all CERES HDF output science products.

Table ‑. CERES\_metadata Vdata

|  |  |  |  |
| --- | --- | --- | --- |
| Item | Parameter Name | Range | Data Type |
| 1 | ShortName | N/A | s(32) |
| 2 | RangeBeginningDate | 1997-11-19 .. 2050-12-31 | s(32) |
| 3 | RangeBeginningTime | 00:00:00.000000Z .. 24:00:00:000000Z | s(32) |
| 4 | RangeEndingDate | 1997-11-19 .. 2050-12-31 | s(32) |
| 5 | RangeEndingTime | 00:00:00.000000Z .. 24:00:00:000000Z | s(32) |
| 6 | AutomaticQualityFlag | Passed, Failed, or Suspect | s(64) |
| 7 | AutomaticQualityFlagExplanation | N/A | s(256) |
| 8 | AssociatedPlatformShortName | TRMM, Terra, Aqua,  EOS AM-1, EOS PM-1, NPP, TBD | s(32) |
| 9 | AssociatedInstrumentShortName | PFM, FM1, FM2, FM3, FM4, FM5, TBD | s(32) |
| 10 | LocalGranuleID | N/A | s(96) |
| 11 | LocalVersionID | N/A | s(64) |
| 12 | CERProductionDateTime | N/A | s(32) |
| 13 | NumberofRecords | 1 .. 9 999 999 999 | 4-byte Integer |
| 14 | ProductGenerationLOC | SGI\_xxx, TBD | s(256) |

The BDS Product Specific Attribute (PSA) metadata are listed in . The definitions that are nearly identical for several parameters are defined only once, even though individually distinct parameters exist as shown in the table below.

| Table ‑. BDS Product Specific Metadata Parameters | | | |
| --- | --- | --- | --- |
| Item | Parameter Name | Range | Data Type |
| 1 |  | XTRK/RAPS/FAPS, RAPS/FAPS,  FAPS ONLY, RAPS ONLY, XTRK ONLY,  XTRK/RAPS, XTRK/FAPS, | s(14) |
| 2 |  | Off, On | s(3) |
| 3 |  | Real, Pred, Sim | s(4) |
| 4 |  | Real, Sim | s(4) |
| 5 |  | 0.0 .. 100.0 | F11.6 |
| 6 |  | 0.0 .. 100.0 | F11.6 |
| 7 |  | 0.0 .. 100.0 | F11.6 |
| 8 |  | 0.0 .. 100.0 | F11.6 |
| 9 |  | 0.0 .. 100.0 | F11.6 |
| 10 |  | 0.0 .. 100.0 | F11.6 |
| 11 |  | 0.0 .. 100.0 | F11.6 |
| 12 |  | CERES-TOA or WGS84 | s(9) |
| 13 |  | 1 .. n | U32Int |
|  |  | Record Size (bytes) = 72 |  |

PSA-1 Scan Mode

A flag that indicates which scan mode the instrument was operating in during data collection.

PSA-2 Second Time Constant Mode

A flag that specifies if the second time constant numerical filter was invoked during science processing.

PSA-3 Ephemeris Data Used

PSA-4 Attitude Data Used

A flag that indicates which type of ephemeris/attitude data were used during science processing.

PSA-5 Percent Shortwave Channel Bad

PSA-6 Percent Total Channel Bad

PSA-7 Percent Window Channel Bad

The percent of radiance samples that failed various edit checks and were then marked Bad during science processing.

PSA-8 Percent FAPS

PSA-9 Percent RAPS

PSA-10 Percent Crosstrack

PSA-11 Percent Transitional

Percent of samples in a particular scan mode during data collection.

PSA-12 TOA\_Model\_Used

A flag that indicates which Earth model was used during the science processing.

PSA-13 NumberInputFiles

The number of input files used to create the BDS data product, which includes Level 0 files, ephemeris and attitude files, and ancillary input files (e.g., count conversion offsets and gains).

Instrument Data Reference Material

Raw Digital Status Description

contains a list of the BDS Raw Digital Status Data. The data descriptions following the table apply to both the raw and converted digital status parameters (See ). Definitions are hyperlinked by the Link column and the DRL-64 Reference column entries. The raw digital status data are primarily data internal to the instrument microprocessors. Some data from analog sensors (e.g., heatsink temperatures) that are digitized for microprocessor usage are also included. Digitization is accomplished using a Digital-to-Analog Converter (DAC).

| Table ‑. Raw Digital Status Data | | | | | |
| --- | --- | --- | --- | --- | --- |
| Link | **Word** | **Parameter Name** | **Bit**  Order | Nominal  Values\* | DRL-64  Reference |
|  | 0 | Instrument Mode Sequence Number | 0 .. 4 | 0 .. 10 |  |
|  | Instrument Previous Mode Sequence Number | 5 .. 9 | 0 .. 10 |  |
|  | Mode Sequence Changed By | 10 .. 12 | 0 .. 3 |  |
|  | Mode Sequence Has Changed | 13 .. 14 | 0 |  |
|  | Spare Bit | 15 | 0 |  |
|  | 1 | Sequence Command Index | 0 .. 4 | 0 .. 31 |  |
|  | Sequence Execution Status | 5 .. 7 | 0 .. 3 |  |
|  | Sequence Time to Next Command | 8 .. 15 | 0 .. 255 |  |
|  | 2 | Spare Word (PFM, FM1, FM2, FM5) | 0 .. 15 | 0 |  |
|  | Time\_Mark\_Sample\_Number (FM3, FM4) | 0 .. 15 |  |  |
|  | 3 | Spare Word (PFM, FM1, FM2, FM5) | 0 .. 15 | 0 |  |
|  | Time\_Mark\_MicroSeconds (FM3, FM4) | 0 .. 15 |  |  |
|  | 4 | Spare Word (PFM, FM1, FM2, FM5) | 0 .. 15 | 0 |  |
|  | Time\_Code\_Sample\_Number (FM3, FM4) | 0 .. 15 |  |  |
|  | 5 | Spare Word (PFM, FM1, FM2, FM5) | 0 .. 15 | 0 |  |
|  | Time\_Code\_MicroSeconds(FM3, FM4) | 0 .. 15 |  |  |
|  | 6 | Spare Word (PFM, FM1, FM2, FM3, FM4, FM5) | 0 .. 15 | 0 |  |
|  | 7 | Instrument Command Counter | 0 .. 15 | 0 .. 65535 |  |
|  | 8 | Instrument Command Main 1 | 0 .. 15 | 0 .. 65535 |  |
|  | 9 | Instrument Command Parameter 1 | 0 .. 15 | 0 .. 65535 |  |
|  | 10 | Instrument Command Sample Number 1 | 0 .. 9 | 0 .. 659 |  |
|  | Instrument Command Status 1 | 10 .. 14 | 0 .. 14 |  |
|  | Instrument Command Source 1 | 15 | 0 .. 1 |  |
|  | 11 | Instrument Command Main 2 | 0 .. 15 | 0 .. 65535 |  |
|  | 12 | Instrument Command Parameter 2 | 0 .. 15 | 0 .. 65535 |  |
|  | 13 | Instrument Command Sample Number 2 | 0..9 | 0 .. 659 |  |
|  | Instrument Command Status 2 | 10 .. 14 | 0 .. 14 |  |
|  | Instrument Command Source 2 | 15 | 0 .. 1 |  |
|  | 14 | Instrument Command Main 3 | 0 .. 15 | 0 .. 65535 |  |
|  | 15 | Instrument Command Parameter 3 | 0 .. 15 | 0 .. 65535 |  |
|  | 16 | Instrument Command Sample Number 3 | 0 .. 9 | 0 .. 659 |  |
|  | Instrument Command Status 3 | 10 .. 14 | 0 .. 14 |  |
|  | Instrument Command Source 3 | 15 | 0 .. 1 |  |
|  | 17 | Instrument Command Main 4 | 0 .. 15 | 0 .. 65535 |  |
|  | 18 | Instrument Command Parameter 4 | 0 .. 15 | 0 .. 65535 |  |
|  | 19 | Instrument Command Sample Number 4 | 0 .. 9 | 0 .. 659 |  |
|  | Instrument Command Status 4 | 10 .. 14 | 0 .. 14 |  |
|  | Instrument Command Source 4 | 15 | 0 .. 1 |  |
|  | 20 | Instrument Command Main 5 | 0 .. 15 | 0 .. 65535 |  |
|  | 21 | Instrument Command Parameter 5 | 0 .. 15 | 0 .. 65535 |  |
|  | 22 | Instrument Command Sample Number 5 | 0 .. 9 | 0 .. 659 |  |
|  | Instrument Command Status 5 | 10 .. 14 | 0 .. 14 |  |
|  | Instrument Command Source 5 | 15 | 0 .. 1 |  |
|  | 23 | Instrument Command Main 6 | 0 .. 15 | 0 .. 65535 |  |
|  | 24 | Instrument Command Parameter 6 | 0 .. 15 | 0 .. 65535 |  |
|  | 25 | Instrument Command Sample Number 6 | 0 .. 9 | 0 .. 659 |  |
|  | Instrument Command Status 6 | 10 .. 14 | 0 .. 14 |  |
|  | Instrument Command Source 6 | 15 | 0 .. 1 |  |
|  | 26 | Instrument Command Main 7 | 0 .. 15 | 0 .. 65535 |  |
|  | 27 | Instrument Command Parameter 7 | 0 .. 15 | 0 .. 65535 |  |
|  | 28 | Instrument Command Sample Number 7 | 0 .. 9 | 0 .. 659 |  |
|  | Instrument Command Status 7 | 10 .. 14 | 0 .. 14 |  |
|  | Instrument Command Source 7 | 15 | 0 .. 1 |  |
|  | 29 | Instrument Command Main 8 | 0 .. 15 | 0 .. 65535 |  |
|  | 30 | Instrument Command Parameter 8 | 0 .. 15 | 0 .. 65535 |  |
|  | 31 | Instrument Command Sample Number 8 | 0 .. 9 | 0 .. 659 |  |
|  | Instrument Command Status 8 | 10 .. 14 | 0 .. 14 |  |
|  | Instrument Command Source 8 | 15 | 0 .. 1 |  |
|  | 32 | Instrument Error Counter | 0 .. 15 | 0 .. 65535 |  |
|  | 33 | Instrument Error Sample Number 1 | 0 .. 9 | 0 .. 659 |  |
|  | Instrument Error Type 1 | 10 .. 15 | 0 .. 63 |  |
|  | 34 | Instrument Error Sample Number 2 | 0 .. 9 | 0 .. 659 |  |
|  | Instrument Error Type 2 | 10 .. 15 | 0 .. 63 |  |
|  | 35 | Instrument Error Sample Number 3 | 0 .. 9 | 0 .. 659 |  |
|  | Instrument Error Type 3 | 10 .. 15 | 0 .. 63 |  |
|  | 36 | Instrument Error Sample Number 4 | 0 .. 9 | 0 .. 659 |  |
|  | Instrument Error Type 4 | 10 .. 15 | 0 .. 63 |  |
|  | 37 | Instrument Error Sample Number 5 | 0 .. 9 | 0 .. 659 |  |
|  | Instrument Error Type 5 | 10 .. 15 | 0 .. 63 |  |
|  | 38 | Instrument Error Sample Number 6 | 0 .. 9 | 0 .. 659 |  |
|  | Instrument Error Type 6 | 10 .. 15 | 0 .. 63 |  |
|  | 39 | Instrument Error Sample Number 7 | 0 .. 9 | 0 .. 659 |  |
|  | Instrument Error Type 7 | 10 .. 15 | 0 .. 63 |  |
|  | 40 | Instrument Error Sample Number 8 | 0 .. 9 | 0 .. 659 |  |
|  | Instrument Error Type 8 | 10 .. 15 | 0 .. 63 |  |
|  | 41 .. 45 | Spare Words (All Instruments) | 0 .. 15 | 0 |  |
|  | 46 | TOT Bridge Balance Control Status | 0 .. 2 | 0 .. 2 |  |
|  | TOT Bridge Balance DAC Update Status Value | 3 | 0 .. 1 |  |
|  | TOT Bridge Balance Reset Counter | 4 .. 8 | 0 .. 24 |  |
|  | Spare Bits | 9 .. 15 | 0 |  |
|  | 47 | TOT Spacelook Average | 0 .. 11 | 0 .. 4095 |  |
|  | Spare Bits | 12 .. 15 | 0 |  |
|  | 48 | TOT Bridge Balance DAC Coarse Value | 0 .. 11 | 0 .. 4095 |  |
|  | Spare Bits | 12 .. 15 | 0 |  |
|  | 49 | TOT Bridge Balance DAC Fine Value | 0 .. 11 | 0 .. 4095 |  |
|  | Spare Bits | 12 .. 15 | 0 |  |
|  | 50 | SW Bridge Balance Control Status | 0 .. 2 | 0 .. 2 |  |
|  | SW Bridge Balance DAC Update Status Value | 3 | 0 .. 1 |  |
|  | SW Bridge Balance Reset Counter | 4 .. 8 | 0 .. 24 |  |
|  | Spare Bits | 9 .. 15 | 0 |  |
|  | 51 | SW Spacelook Average | 0 .. 11 | 0 .. 4095 |  |
|  | Spare Bits | 12 .. 15 | 0 |  |
|  | 52 | SW Bridge Balance DAC Coarse Value | 0 .. 11 | 0 .. 4095 |  |
|  | Spare Bits | 12 .. 15 | 0 |  |
|  | 53 | SW Bridge Balance DAC Fine Value | 0 .. 11 | 0 .. 4095 |  |
|  | Spare Bits | 12 .. 15 | 0 |  |
|  | 54 | WN Bridge Balance Control Status | 0 .. 2 | 0 .. 2 |  |
|  | WN Bridge DAC Update Status Value | 3 | 0 .. 1 |  |
|  | WN Bridge Balance Reset Counter | 4 .. 8 | 0 .. 24 |  |
|  | Spare Bits | 9 .. 15 | 0 |  |
|  | 55 | WN Spacelook Average | 0 .. 11 | 0 .. 4095 |  |
|  | Spare Bits | 12 .. 15 | 0 |  |
|  | 56 | WN Bridge Balance DAC Coarse Value | 0 .. 11 | 0 .. 4095 |  |
|  | Spare Bits | 12 .. 15 | 0 |  |
|  | 57 | WN Bridge Balance DAC Fine Value | 0 .. 11 | 0 .. 4095 |  |
|  |  | Spare Bits | 12 .. 15 | 0 |  |
|  | 58 | Bridge Balance Spacelook Start Sample Number | 0 .. 9 | 5 |  |
|  | Spare Bits | 10 .. 15 | 0 |  |
|  | 59 | Bridge Balance Spacelook End Sample Number | 0 .. 9 | 25 |  |
|  | Spare Bits | 10 .. 15 | 0 |  |
|  | 60 | Bridge Balance DAC Update Sample Number | 0 .. 9 | 644 |  |
|  | Spare Bits | 10 .. 15 | 0 |  |
|  | 61 | Bridge Balance Window High Value | 0 .. 11 | 300 |  |
|  | Spare Bits | 12 .. 15 | 0 |  |
|  | 62 | Bridge Balance Window Low Value | 0 .. 11 | 50 |  |
|  | Spare Bits | 12 .. 15 | 0 |  |
|  | 63 | Bridge Balance Window Setpoint Value | 0 .. 11 | 225 |  |
|  | Spare Bits | 12 .. 15 | 0 |  |
|  | 64 | TOT Detector Temperature Setpoint | 0 .. 11 | 0 .. 4095 |  |
|  | TOT Detector Temperature Control Status | 12 | 0 .. 1 |  |
|  | Spare Bits | 13 .. 15 | 0 |  |
|  | 65 | SW Detector Temperature Setpoint | 0 .. 11 | 0 .. 4095 |  |
|  | SW Detector Temperature Control Status | 12 | 0 .. 1 |  |
|  | Spare Bits | 13 .. 15 | 0 |  |
|  | 66 | WN Detector Temperature Setpoint | 0 .. 11 | 0 .. 4095 |  |
|  | WN Detector Temperature Control Status | 12 | 0 .. 1 |  |
|  | Spare Bits | 13 .. 15 | 0 |  |
|  | 67 | Blackbody Temperature Setpoint | 0 .. 11 | 0 .. 4095 |  |
|  | Blackbody Temperature Control Status | 12 | 0 .. 1 |  |
|  | Spare Bits | 13 .. 15 | 0 |  |
|  | 68 | SWICS Intensity Level | 0 .. 1 | 0 .. 3 |  |
|  | Spare Bits | 2 .. 15 | 0 |  |
|  | 69 | Spare Word (All Instruments) | 0 .. 15 | 0 |  |
|  | 70 | Elevation Scan Mode | 0 .. 4 | 0 .. 4 |  |
|  | Elevation On Deck Scan Mode | 5 .. 9 | 0 .. 4 |  |
|  | Elevation Scan Status | 10 .. 12 | 0 .. 4 |  |
|  | Elevation Motor Drive | 13 | 0 .. 1 |  |
|  | Elevation Encoder LED Intensity | 14 | 0 .. 1 |  |
|  | Elevation Stall | 15 | 0 .. 1 |  |
|  | 71 | Elevation Offset Correction | 0 .. 15 | 65082 |  |
|  | 72 | Elevation Stall Error Threshold | 0 .. 15 | 32767 |  |
|  | 73 | Elevation Stall Count Threshold | 0 .. 9 | 660 |  |
|  | Spare Bits | 10 .. 15 | 0 |  |
|  | 74 | Elevation Position Error Sample 1 | 0 .. 15 | 0 .. 65535 |  |
|  | 75 | Elevation Position Error Sample 2 | 0 .. 15 | 0 .. 65535 |  |
|  | 76 | Elevation Position Error Sample 3 | 0 .. 15 | 0 .. 65535 |  |
|  | 77 | Main Cover Command | 0 .. 3 | 0 .. 5 |  |
|  | Main Cover Motion Status | 4 .. 7 | 0 .. 15 |  |
|  | Main Cover Position Status | 8 .. 11 | 0 .. 4 |  |
|  | Main Cover Sensor Active | 12 .. 13 | 0 .. 1 |  |
|  | Spare Bits | 14 .. 15 | 0 |  |
|  | 78 | Main Cover Commanded Position | 0 .. 11 | 0 .. 4095 |  |
|  | Spare Bits | 12 .. 15 | 0 |  |
|  | 79 | Main Cover Accumulated Lag Error Sensor 1 | 0 .. 7 | 0 .. 255 |  |
|  | Spare Bits | 8 .. 15 | 0 |  |
|  | 80 | Main Cover Accumulated Lag Error Sensor 2 | 0 .. 7 | 0 .. 255 |  |
|  | Spare Bits | 8 .. 15 | 0 |  |
|  | 81 | Main Cover Fixed Step Count | 0 .. 15 | 0 .. 65535 |  |
|  | 82 | Main Cover Defined Closed Position | 0 .. 11 | 241 |  |
|  | Spare Bits | 12 .. 15 | 0 |  |
|  | 83 | Main Cover Defined Open Position | 0 .. 11 | 3164 |  |
|  | Spare Bits | 12 .. 15 | 0 |  |
|  | 84 | Main Cover Defined Closed Margin | 0 .. 11 | 30 |  |
|  | Spare Bits | 12 .. 15 | 0 |  |
|  | 85 | Main Cover Defined Open Margin | 0 .. 11 | 30 |  |
|  | Spare Bits | 12 .. 15 | 0 |  |
|  | 86 | MAM Cover Command | 0 .. 3 | 0 .. 5 |  |
|  | MAM Cover Motion Status | 4 .. 7 | 0 .. 15 |  |
|  | MAM Cover Position Status | 8 .. 11 | 0 .. 4 |  |
|  | MAM Cover Sensor Active | 12 .. 13 | 0 .. 1 |  |
|  | Spare Bits | 14 .. 15 | 0 |  |
|  | 87 | MAM Cover Commanded Position | 0 .. 11 | 0 .. 4095 |  |
|  | Spare Bits | 12 .. 15 | 0 |  |
|  | 88 .. 89 | Spare Words (All Instruments) | 0 .. 15 | 0 |  |
|  | 90 | MAM Cover Fixed Step Count | 0 .. 15 | 0 .. 65535 |  |
|  | 91 | MAM Cover Defined Closed Position | 0 .. 11 | 801 |  |
|  | Spare Bits | 12 .. 15 | 0 |  |
|  | 92 | MAM Cover Defined Open Position | 0 .. 11 | 1924 |  |
|  | Spare Bits | 12 .. 15 | 0 |  |
|  | 93 | MAM Cover Defined Closed Margin | 0 .. 11 | 20 |  |
|  | Spare Bits | 12 .. 15 | 0 |  |
|  | 94 | MAM Cover Defined Open Margin | 0 .. 11 | 20 |  |
|  | Spare Bits | 12 .. 15 | 0 |  |
|  | 95 | DAP Watchdog Boot Status | 0 | 0 .. 1 |  |
|  | DAP Watchdog Enable Status | 1 | 0 .. 1 |  |
|  | DAP PROM Power Status | 2 | 0 .. 1 |  |
|  | DAP Sample Clock Interrupt Occurred | 3 .. 4 | 0 |  |
|  | Spare Bits | 5 .. 15 | 0 |  |
|  | 96 | DAP Processor Scan Period Count | 0 .. 15 | 0 .. 65535 |  |
|  | 97 | DAP Memory Dump Start Address Offset | 0 .. 15 | 0 .. 65535 |  |
|  | 98 | DAP Memory Dump Start Address Segment | 0 .. 15 | 0 .. 65535 |  |
|  | 99 | DAP Memory Dump End Address Offset | 0 .. 15 | 0 .. 65535 |  |
|  | 100 | DAP Memory Dump End Address Segment | 0 .. 15 | 0 .. 65535 |  |
|  | 101 | DAP Packet Start Address Offset | 0 .. 15 | 0 .. 65535 |  |
|  | 102 | DAP Packet Start Address Segment | 0 .. 15 | 0 .. 65535 |  |
|  | 103 | DAP Address Changes Indicator | 0 .. 15 | 0 |  |
|  | 104 | DAP Minimum Execution Time | 0 .. 15 | 0 .. 65535 |  |
|  | 105 | DAP Minimum Sample Number | 0 .. 10 | 0 .. 659 |  |
|  | Spare Bits | 11 .. 15 | 0 |  |
|  | 106 | DAP Maximum Execution Time | 0 .. 15 | 0 .. 65535 |  |
|  | 107 | DAP Maximum Sample Number | 0 .. 10 | 0 .. 659 |  |
|  | Spare Bits | 11 .. 15 | 0 |  |
|  | 108 | DAP RAM Code Checksum | 0 .. 15 | 0 .. 65535 |  |
|  | 109 | DAP ROM Code Checksum | 0 .. 15 | 0 .. 65535 |  |
|  | 110 .. 114 | Spare Words (All Instruments) | 0 .. 15 | 0 |  |
|  | 115 | Azimuth Mode | 0 .. 4 | 0 .. 10 |  |
|  | Azimuth Motion Status | 5 | 0 .. 1 |  |
|  | Azimuth Direction Status | 6 | 0 .. 1 |  |
|  | Azimuth Position Status | 7 .. 10 | 0 .. 4 |  |
|  | Azimuth Motor Drive Status | 11 | 0 .. 1 |  |
|  | Azimuth Encoder LED Status | 12 | 0 .. 1 |  |
|  | Azimuth Stall | 13 | 0 .. 1 |  |
|  | Spare Bits | 14 .. 15 | 0 |  |
|  | 116 | Azimuth Defined Crosstrack Position | 0 .. 15 | 32773 |  |
|  | 117 | Azimuth Defined Fixed Position A | 0 .. 15 | 16389\*\* |  |
|  | 118 | Azimuth Defined Fixed Position B | 0 .. 15 | 49157\*\* |  |
|  | 119 | Azimuth Defined Fixed Solar Calibration Position | 0 .. 15 | 0 .. 65535 |  |
|  | 120 | Azimuth Defined Fixed Cage Position | 0 .. 15 | 21 |  |
|  | 121 | Azimuth Defined Fixed Position Spare 1 | 0 .. 15 | 8197 |  |
|  | 122 | Azimuth Defined Fixed Position Spare 2 | 0 .. 15 | 30000 |  |
|  | 123 | Azimuth Defined Fixed Position Spare 3 | 0 .. 15 | 60000 |  |
|  | 124 | Azimuth Defined Normal Slew Rate | 0 .. 15 | 1371 |  |
|  | 125 | Azimuth Defined Asynchronous Scan Rate | 0 .. 15 | 1096 |  |
|  | 126 | Azimuth Defined Synchronous Scan Rate | 0 .. 15 | 913 |  |
|  | 127 | Azimuth Offset Correction | 0 .. 15 | 65394 |  |
|  | 128 | Azimuth Stall Error Threshold | 0 .. 15 | 500 |  |
|  | 129 | Azimuth Stall Count Threshold | 0 .. 9 | 10 |  |
|  | Spare Bits | 10 .. 15 | 0 |  |
|  | 130 | Brake Command Status | 0 .. 3 | 0 .. 5 |  |
|  | Brake Motion Status | 4 .. 7 | 0 .. 15 |  |
|  | Brake Position Status | 8 .. 11 | 0 .. 4 |  |
|  | Spare Bits | 12 .. 15 | 0 |  |
|  | 131 | Brake Commanded Position | 0 .. 11 | 0 .. 4095 |  |
|  | Spare Bits | 12 .. 15 | 0 |  |
|  | 132 | Brake Current Position | 0 .. 11 | 0 .. 4095 |  |
|  | Spare Bits | 12 .. 15 | 0 |  |
|  | 133 | Brake Position SUBMUX Channel | 0 .. 7 | 163 |  |
|  | Spare Bits | 8 .. 15 | 0 |  |
|  | 134 | Brake Step Count | 0 .. 15 | 0 .. 65535 |  |
|  | 135 | Brake Defined Released Position | 0 .. 11 | 800 |  |
|  | Spare Bits | 12 .. 15 | 0 |  |
|  | 136 | Brake Defined Applied Position | 0 .. 11 | 685 |  |
|  | Spare Bits | 12 .. 15 | 0 |  |
|  | 137 | Brake Defined Cage Position | 0 .. 11 | 1027 |  |
|  | Spare Bits | 12 .. 15 | 0 |  |
|  | 138 | Brake Defined Released Margin | 0 .. 11 | 50 |  |
|  | Spare Bits | 12 .. 15 | 0 |  |
|  | 139 | Brake Defined Applied Margin | 0 .. 11 | 5 |  |
|  | Spare Bits | 12 .. 15 | 0 |  |
|  | 140 | Brake Defined Cage Margin | 0 .. 11 | 5 |  |
|  | Spare Bits | 12 .. 15 | 0 |  |
|  | 141 | Azimuth Position Error Value | 0 .. 15 | 0 .. 65535 |  |
|  | 142  (TRMM word) | Safehold Input A Status | 0 | 0 .. 1 |  |
|  | Safehold Input B Status | 1 | 0 .. 1 |  |
|  | Safehold Response A Status | 2 .. 3 | 0 .. 3 |  |
|  | Safehold Response B Status | 4 .. 5 | 0 .. 3 |  |
|  | Spare Bits | 6 .. 15 | 0 |  |
|  | 142  (Terra  word) | Low Rate Science Transfer Status | 0 | 0 .. 1 |  |
|  | Safemode Signal Received | 1 | 0 .. 1 |  |
|  | Safemode Signal Response | 2 | 0 .. 1 |  |
|  | IMOK Signal Received | 3 | 0 .. 1 |  |
|  | IMOK Signal Response | 4 | 0 .. 1 |  |
|  | Time Mark & Frequency Bus Select | 5 | 0 .. 1 |  |
|  | Time Mark & Frequency Interrupt | 6 | 0 .. 1 |  |
|  | Spare Bits | 7 .. 15 | 0 |  |
|  | 142  (Aqua  word) | Spare Bits | 0 .. 4 | 0 |  |
|  | Time Mark & Frequency Bus Select | 5 | 0 .. 1 |  |
|  | Time Mark & Frequency Interrupt | 6 | 0 .. 1 |  |
|  | Spare Bits | 7 .. 15 | 0 |  |
|  | 142  (S-NPP  word) | Spare Bits | 0 .. 2 | 0 |  |
|  | IMOK Signal Received | 3 | 0 .. 1 |  |
|  | IMOK Signal Response | 4 | 0 .. 1 |  |
|  | Time Mark & Frequency Bus Select | 5 | 0 .. 1 |  |
|  | Time Mark & Frequency Interrupt | 6 | 0 .. 1 |  |
|  | Spare Bits | 7 .. 15 | 0 |  |
|  | 143 | ICP Watchdog Boot Status | 0 | 0 .. 1 |  |
|  | ICP Watchdog Enable Status | 1 | 0 .. 1 |  |
|  | ICP PROM Power Status | 2 | 0 .. 1 |  |
|  | ICP Sample Clock Interrupt Occurred | 3 .. 4 | 0 |  |
|  | DMA Communication Status | 5 .. 7 | 0 .. 3 |  |
|  | Spare Bits | 8 .. 15 | 0 |  |
|  | 144 | ICP Scan Period Counter | 0 .. 15 | 0 .. 65535 |  |
|  | 145 | ICP Memory Dump Start Address Offset | 0 .. 15 | 0 .. 65535 |  |
|  | 146 | ICP Memory Dump Start Address Segment | 0 .. 15 | 0 .. 65535 |  |
|  | 147 | ICP Memory Dump End Address Offset | 0 .. 15 | 0 .. 65535 |  |
|  | 148 | ICP Memory Dump End Address Segment | 0 .. 15 | 0 .. 65535 |  |
|  | 149 | ICP Packet Start Address Offset | 0 .. 15 | 0 .. 65535 |  |
|  | 150 | ICP Packet Start Address Segment | 0 .. 15 | 0 .. 65535 |  |
|  | 151 | ICP Address Changed Indicator | 0 .. 15 | 0 |  |
|  | 152 | ICP Minimum Execution Time | 0 .. 15 | 0 .. 65535 |  |
|  | 153 | ICP Minimum Sample Number | 0 .. 10 | 0 .. 659 |  |
|  | Spare Bits | 11 .. 15 | 0 |  |
|  | 154 | ICP Maximum Execution Time | 0 .. 15 | 0 .. 65535 |  |
|  | 155 | ICP Maximum Sample Number | 0 .. 10 | 0 .. 659 |  |
|  | Spare Bits | 11 .. 15 | 0 |  |
|  | 156 | ICP RAM Code Checksum | 0 .. 15 | 0 .. 65535 |  |
|  | 157 | ICP ROM Code Checksum | 0 .. 15 | 0 .. 65535 |  |
|  | 158 .. 162 | Spare Words (All Instruments) | 0 .. 15 | 0 |  |
|  | 163 | SPS 1 State | 0 | 0 .. 1 |  |
|  | SPS 2 State | 1 | 0 .. 1 |  |
|  | SPS 1 Response | 2 | 0 .. 1 |  |
|  | SPS 2 Response | 3 | 0 .. 1 |  |
|  | Solar Warning | 4 .. 5 | 0 .. 1 |  |
|  | Scan Timeout Response | 6 | 0 .. 1 |  |
|  | Scan Timeout Counting | 7 .. 8 | 0 .. 1 |  |
|  | Scan Timeout Occurred | 9 .. 10 | 0 .. 1 |  |
|  | Spare Bits | 11 .. 15 | 0 |  |
|  | 164 | Solar Warning Event Sample Number | 0 .. 15 | 0 .. 659 |  |
|  | 165 | Solar Warning Event Scan Period | 0 .. 15 | 0 .. 65535 |  |
|  | 166 | Scan Timeout Scan Period | 0 .. 15 | 0 .. 65535 |  |
|  | 167 | SPS 1 Narrow FOV Signal | 0 .. 11 | 0 .. 4095 |  |
|  | Spare Bits | 12 .. 15 | 0 |  |
|  | 168 | SPS 1 Wide FOV Signal | 0 .. 11 | 0 .. 4095 |  |
|  | Spare Bits | 12 .. 15 | 0 |  |
|  | 169 | SPS 1 Threshold Noise | 0 .. 11 | 500 |  |
|  | Spare Bits | 12 .. 15 | 0 |  |
|  | 170 | SPS 1 Threshold Scale Numerator | 0 .. 5 | 32 |  |
|  | Spare Bits | 6 .. 15 | 0 |  |
|  | 171 | SPS 1 Solar Detection State | 0 | 0 .. 1 |  |
|  | Spare Bits | 1 .. 15 | 0 |  |
|  | 172 | SPS 1 Solar Detection Count | 0 .. 9 | 0 .. 55 |  |
|  | Spare Bits | 10 .. 15 | 0 |  |
|  | 173 | SPS 1 Solar Detection Count Threshold | 0 .. 9 | 5 |  |
|  | Spare Bits | 10 .. 15 | 0 |  |
|  | 174 | SPS 1 Solar Detection Max Count | 0 .. 9 | 0 .. 55 |  |
|  | Spare Bits | 10 .. 15 | 0 |  |
|  | 175 | SPS 2 Narrow FOV Signal | 0 .. 11 | 0 .. 4095 |  |
|  | Spare Bits | 12 .. 15 | 0 |  |
|  | 176 | SPS 2 Wide FOV Signal | 0 .. 11 | 0 .. 4095 |  |
|  |  | Spare Bits | 12 .. 15 | 0 |  |
|  | 177 | SPS 2 Threshold Noise | 0 .. 11 | 500 |  |
|  | Spare Bits | 12 .. 15 | 0 |  |
|  | 178 | SPS 2 Threshold Scale Numerator | 0 .. 5 | 32 |  |
|  | Spare Bits | 6 .. 15 | 0 |  |
|  | 179 | SPS 2 Solar Detection State | 0 | 0 .. 1 |  |
|  | Spare Bits | 1 .. 15 | 0 |  |
|  | 180 | SPS 2 Solar Detection Count | 0 .. 9 | 0 .. 55 |  |
|  | Spare Bits | 10 .. 15 | 0 |  |
|  | 181 | SPS 2 Solar Detection Count Threshold | 0 .. 9 | 5 |  |
|  | Spare Bits | 10 .. 15 | 0 |  |
|  | 182 | SPS 2 Solar Detection Max Count | 0 .. 9 | 0 .. 55 |  |
|  | Spare Bits | 10 .. 15 | 0 |  |
|  | 183 | Solar Avoidance Initial Scan Count | 0 .. 9 | 0 .. 1000 |  |
|  | Spare Bits | 10 .. 15 | 0 |  |
|  | 184 | Solar Avoidance Current Scan Count | 0 .. 9 | 0 .. 1000 |  |
|  | Spare Bits | 10 .. 15 | 0 |  |
| \* Values in this column typically represents flight condition expected ranges, nominal single values, or enumerated values. Ranges specified will not necessarily use the total number of bits available for a given parameter, but will not exceed the maximum number available.  \*\* See description of Azimuth Position A/B for other possible values. | | | | | |

DS-1 Instrument Mode Sequence Number

This parameter indicates the current internal mode sequence that is either being executed or has completed execution. The enumeration of this value is in , note . The detailed sequences for each mode are found in Reference (DRL-87). This parameter reflects the

SET\_INSTRUMENT\_MODE command. This parameter will not reflect short commands that effectively place the instrument into another “mode configuration”.

DS-2 Instrument Previous Mode Sequence Number

This parameter indicates the internal mode sequence that was previously executed. The enumeration of this value is in , note . The detailed sequences for each mode are found in DRL-87 (See Reference ) . These values are the same as the Instrument Mode Sequence Number.

DS-3 Mode Sequence Changed By

This parameter indicates whether the current internal mode sequence was initiated by a spacecraft or internal instrument command or a safing operation (spacecraft safehold or solar avoidances). See , note .

DS-4 Mode Sequence Has Changed

This parameter is for internal flight code usage and is used for instrument ground testing only. This value should always = 0.

DS-5 Sequence Command Index

This parameter is a counter that points to the current short command being executed within an internal mode sequence or will contain the last sequence command at the completion of a sequence. The index range is nominally 0 .. 35.

DS-6 Sequence Execution Status

This parameter indicates the current state of an internal mode sequence execution within a packet. This status is required since most sequences typically execute over multiple packets and are often synchronized to the azimuth gimbal motions (e.g., Waiting\_For\_Azimuth motion to complete) and packet boundaries (e.g., Waiting\_For\_Next\_Scan). The enumeration of this value is in , note . Azimuth gimbal synchronizations are required to prevent the bolometers from potentially viewing the Sun.

DS-7 Sequence Time to Next Command

This parameter indicates the time remaining before the next command is to be executed in a currently executing mode sequence. This can provide the user with scheduling information so that external short commands will not overlap sequences in the middle of execution unless it is another mode sequence command. The converted value is computed using DRL-64 (See Reference ) Algorithm Linear Coefficients listed in .

DS-8 Instrument Command Counter

This parameter is a 16-bit counter that reflects the latest number of instrument command received on the command echo stack, regardless of its executability or source. However, if the instrument is unable to receive the command (e.g., via the spacecraft interface bus), this counter will not be updated. The corresponding command will also not be placed on the stack.

DS-9 Instrument On-board Command Stack Parameters

The next forty parameters are associated with the on-board command stack that holds up to 8 commands each containing:

* Instrument Command Main 1-8
* Instrument Command Parameter 1-8
* Instrument Command Sample Number 1-8
* Instrument Command Status 1-8
* Instrument Command Source 1-8

The detailed breakdown of the 8 Instrument Command Main and 8 Instrument Command Parameters are shown in . The Instrument Command Sample Number indicates the sample number within the scan in which the command was received. The Instrument Command Status indicates the results of a given command’s pre-execution correctness check (See , note ). The Instrument Command Source identifies the originator of the command (See , note ).

DS-10 Instrument Error Counter

This parameter reflects the accumulated 16-bit count of any ICP or DAP microprocessor errors.

DS-11 Instrument Error Sample Number 1 - 8/Instrument Error Type 1 - 8

These 16 parameters are associated with the on-board microprocessor error stack that holds up to 8 error conditions each containing an Instrument Error Sample Number and an Instrument Error Type. This stack reflects any flight code execution problems that occurred during instrument operation. This stack is independent of the command stack. The Instrument Error Type values are found in , note . The Error Sample Number indicates the sample number within the scan when the microprocessor error occurred.

DS-12 TOT/SW/WN Bridge Balance Control Status

A parameter for each detector which indicates whether the bridge balance circuitry is off, resetting, or maintaining. See , note . During resets, coarse adjustment updates are performed. During maintaining, fine adjustment updates are made only when the internal spacelook average is between the Bridge Balance Window High Value and Low Values. This parameter reflects the results of the SET\_TOT/SW/WN\_BRIDGE\_BAL\_CONTROL\_MODE command.

DS-13 TOT/SW/WN Bridge Balance DAC Update Status Value

A parameter for each detector which indicates whether the bridge balance circuitry performed a fine adjustment update for the current packet. See , note . Any updating begins on the sample defined by the Bridge Balance DAC Update Sample Number parameter. If an update is needed for any of the three detector channels, then the updating procedure is activated for all three channels at the same time. However, only the selected channel will act on the revised DAC value, and the associated DAC update status parameter will change accordingly.

DS-14 TOT/SW/WN Bridge Balance Reset Counter

A parameter for each detector which indicates the number of scan counts the instrument is using to balance the bridge in a reset condition. The initial count is set by a successive approximation algorithm that estimates the number of scans to bring the bridge back into balance. The initial default value = 24. During resetting operations, this counter is decremented until it reaches zero. If the bridge is still not balanced, the procedure is repeated. Otherwise, the instrument will continue in a maintenance state.

DS-15 TOT/SW/WN Spacelook Average

A parameter for each detector which is an integer average of raw channel radiance counts for the number of samples bounded by the Bridge Balance Spacelook Start Sample Number and Bridge Balance Spacelook End Sample Number. This value is then used to determine if a balance DAC update (or reset) is required.

LVL-0 TOT/SW/WN Bridge Balance DAC Coarse/Fine Value

A parameter for each detector which indicates the current digital value (raw counts) used to control the bridge balance circuitry based on the last commanded value and is then recomputed every packet. These digital values are converted to an analog voltage using a Digital to Analog Converter (DAC). Under nominal conditions, this value should be around the middle of a 12-bit range. These values can be commanded to a set value using the SET\_TOT\_BRID\_BAL\_

COARSE\_DAC\_VALUE or SET\_TOT\_BRID\_BAL\_FINE\_DAC\_VALUE, although these commands are not expected to be used under nominal conditions.

DS-16 Bridge Balance Spacelook Start/End/Update Sample Numbers

These parameters indicate the beginning, ending, and updating sample numbers for corresponding radiance count measurements that the flight code will use to determine the bridge balance’s internal spacelook average. These values can only be changed in conjunction with a DAP\_Scan\_Table\_Load long command and are the same for all 3 radiometric channels.

* **Bridge Balance Spacelook Start Sample Number:** Default = 5
* **Bridge Balance Spacelook End Sample Number:** Default = 25
* **Bridge Balance DAC Update Sample Number:** Default = 644

(However, the DAC updating process will actually require six samples, for a range of   
644 .. 649, based on a scan sample count range of 0 .. 659).

DS-17 Bridge Balance Window High/Low Value

These parameters indicate the upper/lower edit limit count value for the spacelook averaging process used to determine if a bridge balance update should occur. These values can only be changed in conjunction with a DAP\_Scan\_Table\_Load long command and are applied to all three radiometric channels. Post launch results has indicated a need to raise the WN channel values and are indicated in the paratheses values..

* **Bridge Balance Window High Value:** Upper edit limit default value = 300 (2175)
* **Bridge Balance Window Low Value:**  Lower edit limit default value = 50 (1925)

DS-18 Bridge Balance Window Setpoint Value

This parameter indicates the target spacelook average count value when the spacelook averaging process performs a bridge balance update. The default value is set = 225 for all three channels.

Post launch results has indicated that the WN channel setpoint be changed to 20150. This value can only be changed in conjunction with a DAP\_Scan\_Table\_Load long command.

DS-19 TOT/SW/WN Detector Temperature Setpoint

A parameter for each detector indicates the current temperature setpoint (in counts) that was last commanded to the heatsink temperature controller. The default value is 2048 (the middle of the 12-bit range). This value can be changed with the SET\_TOT/SW/WN\_SENSOR\_TEMP\_SETPOINT command.

DS-20 TOT/SW/WN Detector Temperature Control Status

A parameter for each detector indicates if the detector heatsink temperature controller is on or off. See , note . The normal default is on. This status can be changed using the SET\_TOT/SW/WN\_SENSOR\_TEMP\_CONTROL command.

DS-21 Blackbody Temperature Setpoint

This parameter indicates the current commanded temperature setpoint for the blackbody internal calibration source. The setpoint is keyed to the total blackbody channel, with the window channel ganged to the total channel. The at-launch default values are typically in counts corresponding to off (0), low (1550), medium (2650), or high (3750) settings. These count values correspond roughly to ~12.06, 31.88, 52.11 degree C, respectively. Post-launch results have resulted in a change to the nominal setpoint temperatature of ~22, ~32, ~42 degee C, respectively. This status value will reflect changes in the SET\_BLACKBODY\_TEMP\_SETPOINT command.

DS-22 Blackbody Temperature Control Status

This parameter indicates if the blackbody heatsink temperature controller is on or off (See , note ). The normal default is off. This status can be changed using the SET\_BLACKBODY\_SENSOR\_TEMP\_CONTROL command.

DS-23 SWICS Intensity Level

This parameter indicates the intensity level of the SWICS calibration source for the current packet. See , note . The default value is 0 (off). This status can be changed using the SET\_SWICS\_INTENSITY command. The Low (~170), Medium (~1400), and High (~3145) count settings correspond roughly to 100, 250, and 400 Wm-2sr-1, respectively.

DS-24 Elevation Scan Mode

This parameter indicates the status of the elevation gimbal scanning profile for the current packet as of the last sample in the current packet. See , note . Since elevation operations always begin and end on packet boundaries, this status will reflect the commanded scan profile that was implemented for the current packet and will be a reflection of the SET\_SCAN\_MODE command. Nominal parameter index values should range from 0 (stow) to 4 (nadir). The remaining index values are for ground testing only and should not be expected to be used on-orbit. The various profiles are shown in . The stow position can be changed by the Set\_Elevation\_Stow\_Pos command, although this is not expected to be used on-orbit.

DS-25 Elevation On Deck Scan Mode

This parameter indicates the scan profile mode that is to be implemented at the beginning of the next scan. See , note . This status reflects operations as of the last sample in the packet. This value is typically a direct reflection of the command SET\_SCAN\_MODE. Nominal parameter index values should range from 0 (stow) to 4 (nadir). The remaining index values are for ground testing only and should not be expected to be used on-orbit. See for details on elevation gimbal operations.

DS-26 Elevation Scan Status

This parameter indicates the status of elevation scan operations for the current packet as of the last sample. See , note . Since elevation operations always begin and end on packet boundaries, this status will reflect the gimbal operations for the whole packet. During nominal scanning, this status value should be 0 (Normal\_Scan\_Operations). During transitions between profiles (e.g., Stow to Normal Earth Scan), this status will most likely indicate 2 (At\_Initialized\_Position). See for details on elevation gimbal operations.

DS-27 Elevation Motor Drive

This parameter indicates whether the elevation gimbal motor is enabled or disabled as of the last sample in the packet. See , note . The motor will automatically be disabled whenever the elevation gimbal is in the stow position. Otherwise, it should be enabled.

DS-28 Elevation Encoder LED Intensity

This parameter indicates whether the LED used to read the elevation gimbal encoder is set to a low or high power setting as of the last sample in the current packet. See , note . The normal condition is a low (0) setting. Over time, environmental conditions are expected to degrade the LED’s optical power output which will require the power to be set to high by the SET\_ELEVATION\_ENCODER\_LED command.

DS-29 Elevation Stall

This parameter indicates if the elevation gimbal has stalled during the current packet. See , note . Stalling occurs whenever the number of encoder counts exceeds the commanded count (i.e., the difference value) by the Elevation Stall Error Threshold AND this condition has occurred for more than Elevation Stall Count Threshold (samples). When a stall occurs, the elevation will be internally commanded to stop and the Elevation Scan Mode should indicate either Scan\_Abort\_In\_Progress or Elevation\_At\_Aborted\_Position.

Table ‑. Elevation Encoder Defined Offset (counts)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| PFM | FM 1 | FM 2 | FM 3 | FM 4 | FM 5 |
| 65082 (-453) | 65319 (-216) | 58 | 48 | 32947 (\*) | 65500 (-13) |
| (\*) FM 4 is installed 180 degrees out-of-phase, per detailed design document. | | | | | |

DS-30 Elevation Stall Error Threshold

This parameter indicates the defined count threshold for the difference between the commanded gimbal position and the actual gimbal position that would indicate a possible gimbal stall condition. The default value is 32767 and can be changed with the SET\_ELEVATION\_STALL\_ERROR\_THRESHOLD command. When this threshold and the Elevation Stall Count Threshold are both exceeded, the elevation gimbal will be internally commanded to stop and the stall status indicator set.

DS-31 Elevation Stall Count Threshold

This parameter indicates the defined threshold for the number of samples the elevation gimbal position error exceeds the Elevation Stall Error Threshold. The default value is 660 samples and can be changed with the SET\_ELEVATION\_STALL\_COUNT\_THRESHOLD command. When this threshold and the Elevation Stall Error Threshold are both exceeded, the Elevation gimbal will be internally commanded to stop and the stall status indicator set.

DS-32 Elevation Position Error Samples 1 - 3

These three parameters indicate the count value corresponding to the difference between the commanded elevation position and the actual encoder position. While this position error value is computed for every sample, a value is output here that corresponds to

* **Sample 1:** sample number 120 (of samples 0 .. 659)
* **Sample 2:** sample number 336 (of samples 0 .. 659)
* **Sample 3:** sample number 505 (of samples 0 .. 659).

DS-33 Main Cover Command

This parameter indicates the last command that was directed to the main cover assembly. See , note . During nominal mission operations, this status should generally indicate Cover\_Stop (0) or Cover\_Open (1). This status will reflect the COMMAND\_COVER\_MAIN, STEP\_MAIN\_COVER\_TO\_OPEN, or STEP\_MAIN\_COVER\_TO\_CLOSE commands. There are no plans to close the cover after initial on-orbit instrument checkout.

DS-34 Main Cover Motion Status

This parameter indicates the motion status of the main cover during the current packet as of the last sample. See , note . During nominal mission operations, this status should generally indicate Cover\_Stopped (0). There are no plans to move the cover after initial on-orbit instrument checkout.

DS-35 Main Cover Position Status

This parameter indicates where the cover is currently positioned as of the last sample in the packet. See , note . During nominal mission operations, this status should generally indicate Cover\_At\_Opened\_Position (1). However, it may also indicate Potentially\_Failed\_Position\_Sensor. This indicator simply means that the cover “overshot” its defined opened (or closed) position and is not indicative of a problem. There are no plans to move the cover after initial on-orbit instrument checkout.

DS-36 Main Cover Sensor Active

This parameter indicates which of the two position sensors is being used to measure the cover position. See , note . The default is sensor\_1 (0). There are two sensors, one for each turnscrew rail and are used during cover motion to sense possible difference drive signals that could cause racking (stalling) by the covers. This status will reflect changes to the SET\_MAIN\_COVER\_ACTIVE\_POSITION\_SENSOR command.

DS-37 Main Cover Commanded Position

This parameter indicates the raw count position the cover was commanded to as of the last sample in the packet. During nominal mission operations, this is expected to correspond to the opened, defined position within defined margins. This status may also reflect fixed stepped commanded positions.

DS-38 Main Cover Accumulated Lag Error Sensor 1 and Sensor 2

These 2 parameters indicate the sum of a lag starting error plus the current lag error. The starting error is equal to the position value when the cover motion command is initiated minus any position difference that may have already accumulated. The current lag error is calculated by taking the absolute value of the estimated position minus the current position read from the corresponding position sensors. The estimated position is calculated as follows:

estimated\_pos = starting\_pos + (motor\_step\_count / number\_steps\_per\_ADC\_count)

The resulting accumulated lag errors for each of the 2 sensors is used for determining possible stalling conditions. Note, stalling conditions are determined in part when this error value exceeds the internal default value or the value set by the Set\_Main\_Cover\_Sensor\_1\_Lag\_Error command for Sensor 1 or Set\_Main\_Cover\_Sensor\_2\_Lag\_Error command for Sensor 2. During nominal mission operations, these values are generally ignored.

DS-39 Main Cover Fixed Step Count

This parameter indicates the current raw count position of the last sample in the packet for any fix-step commanding actions. During nominal mission operations, this value is expected to be zero.

DS-40 Main Cover Defined Closed/Open Position

These two parameters indicate a Main Cover fixed closed/open position setpoint. The nominal default values for each instrument, as specified in the flight codes, are shown in below. These default values can only be changed with a DAP unique memory long command.

Table ‑. Main Cover Default Position Values (counts)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Position Setpoints | PFM | FM 1 | FM 2 | FM 3 | FM 4 | FM 5 |
| Closed - Sensor 1 | 241 | 466 | 296 | 284 | 351 | 350 |
| Closed - Sensor 2 | 238 | 330 | 330 | 232 | 404 | 368 |
| Opened - Sensor 1 | 3164 | 3406 | 3263 | 3262 | 3330 | 3325 |
| Opened - Sensor 2 | 3143 | 3320 | 3227 | 3194 | 3331 | 3307 |

DS-41 Main Cover Defined Closed/Open Margin

These two parameters indicate a Main Cover fixed position allowable margin about the predefined close/open setpoints. The default values for each instrument, as specified in the flight codes, are shown in below. The default values apply to both position sensors 1 and 2 and can only be changed with a DAP unique memory long command

Table ‑. Main Cover Default Margin Values (counts)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Margin Setpoints | PFM | FM 1 | FM 2 | FM 3 | FM 4 | FM 5 |
| Closed - Sensor 1 | 30 | 30 | 30 | 30 | 30 | 30 |
| Closed - Sensor 2 | 30 | 30 | 30 | 30 | 30 | 30 |
| Opened - Sensor 1 | 30 | 30 | 30 | 30 | 30 | 30 |
| Opened - Sensor 2 | 30 | 30 | 30 | 30 | 30 | 30 |

DS-42 MAM Cover Command

This parameter indicates the last command that was directed to the MAM cover assembly. See , note . During nominal mission operations, this status should generally indicate Cover\_Open or Cover\_Stop. This status will reflect the COMMAND\_COVER\_MAM, STEP\_MAM\_COVER\_TO\_OPEN, or STEP\_MAM\_COVER\_TO\_CLOSE commands. There are no plans to close the cover after initial on-orbit instrument checkout.

DS-43 MAM Cover Motion Status

This parameter indicates the motion status of the MAM cover during the current packet as of the last sample. See , note . During nominal mission operations, this status should generally indicate Cover\_Stopped (0). There are no plans to move the cover after initial on-orbit instrument checkout.

DS-44 MAM Cover Sensor Active

This parameter indicates which position sensor is being used to measure the cover position. See , note . The default is sensor\_1 (0) as there is only one sensor used for the MAM cover assembly.

DS-45 MAM Cover Commanded Position

This parameter indicates the raw count position the cover was commanded to as of the last sample in the packet. During nominal mission operations, this is expected to correspond to the opened, defined position within defined margins. This status may also reflect fixed stepped commanded positions.

DS-46 MAM Cover Fixed Step Count

This parameter indicates the current raw count position as of the last sample in the packet for any fix stepping commanding actions. During nominal mission operations, this value is expected to be zero.

DS-47 MAM Cover Defined Closed/Open Position

These two parameters indicate a MAM Cover fixed closed/open position setpoint. The default values can only be changed with a DAP unique memory long command. The default values for each instrument, as specified in the flight codes, are shown in below.

Table ‑. MAM Cover Default Position Values (counts)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Position Setpoints | PFM | FM 1 | FM 2 | FM 3 | FM 4 | FM 5 |
| Closed | 801 | 851 | 846 | 820 | 898 | 821 |
| Opened | 1924 | 1995 | 1980 | 1955 | 2050 | 1957 |

DS-48 MAM Cover Defined Closed/Open Margin

These two parameters indicate a MAM Cover fixed position allowable margin about the predefined close/open setpoints. The default can only be changed with a DAP unique memory long command. The default values for each instrument, as specified in the flight codes, are shown in below.

Table ‑. MAM Cover Default Margin Values (counts)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Margin Setpoints | PFM | FM 1 | FM 2 | FM 3 | FM 4 | FM 5 |
| Closed | 10 | 20 | 20 | 20 | 20 | 20 |
| Opened | 10 | 20 | 20 | 20 | 20 | 20 |

DS-49 DAP/ICP Watchdog Boot Status

This parameter indicates whether an instrument reset was caused by the DAP/ICP watch dog timer or by normal power up. See , note . Default is normal power up.

DS-50 DAP/ICP Watchdog Enable Status

This parameter indicates whether the watchdog timer will generate an instrument reset on the DAP/ICP. See , note . This is commanded using the SET\_WATCHDOG\_

TIMER\_DAP/ICP command. Default is armed. Note, the watchdog is disarmed after a time-out or a commanded reset (not available on the PFM (TRMM) instrument). Instrument recovery procedures should re-arm the watchdog timer.

DS-51 DAP/ICP PROM Power Status

This parameter indicates if the PROM power is on or off. See , note . Normally the PROMs are off except for initial power up. It is expected that within the first packet or two, this status will switch to off. PROM power can be enabled by the SET\_PROM\_POWER\_DAP/ICP command.

DS-52 DAP/ICP Sample Clock Interrupt Occurred

This parameter is an internal instrument flight code only parameter (should always = zero).

DS-53 DAP/ICP Processor Scan Period Count

This parameter indicates the scan period counter associated with the execution of an internal sequence operation. This counter is reset to zero at the start of a sequence and will update at each scan for the duration of the execution time. The count value at the end of a sequence will remain until another sequence is executed.

DS-54 DAP/ICP Memory Dump Start Address Offset/Segment

These parameters indicate the offset/segment portions of a 20-bit memory address corresponding to a memory dump data word starting at the beginning of a packet. For the first packet of a memory dump, these parameters should reflect the SET\_MEM\_DUMP\_START\_OFFSET\_DAP/ICP command or the SET\_MEM\_DUMP\_START\_SEGMENT\_ DAP/ICP command. For subsequent packets, it will be an incremental value.

* **Start Address Offset:** Represents the 16-bits added to the shifted segment address.
* **Start Address Segment:** Represents the 16-bits which is shifted left by 4 bits and summed with the 16-bit offset value to yield the 20-bit absolute address.

DS-55 DAP/ICP Memory Dump End Address Offset/Segment

These parameters indicate the offset/segment portion of memory address corresponding to a memory dump data word for the end of a packet. For the last packet at the end of a memory dump, these parameters should reflect the SET\_MEM\_DUMP\_END\_OFFSET\_DAP/ICP command or the SET\_MEM\_DUMP\_END\_SEGMENT\_ DAP/ICP command.

* **End Address Offset:** Represents the 16-bits added to the shifted segment address.
* **End Address Segment:** Represents the 16-bits which is shifted left by 4 bits and summed with the 16-bit offset value to yield the 20-bit absolute address.

DS-56 DAP/ICP Packet Start Address Offset/Segment

This parameter indicates the offset/segment portion of the memory address for the start of the current packet in a memory dump operation.

* **Start Address Offset:** Represents the 16-bits added to the shifted segment address.
* **Start Address Segment:** Represents the 16-bits which is shifted left by 4 bits and summed with the 16-bit offset value to yield the 20-bit absolute address.

DS-57 DAP/ICP Address Changes Indicator

This parameter is an internal instrument flight code only parameter (should always = zero).

DS-58 DAP/ICP Minimum/Maximum Sample Number

These parameters indicate the sample during the packet when the shortest/longest DAP/ICP execution time occurred. The range is 0 .. 659, inclusive.

DS-59 DAP/ICP RAM Code Checksum

This parameter indicates the internally computed checksum value for the DAP/ICP RAM (Random Access Memory) code. This value is updated whenever new memory patches are loaded using the DAP/ICP\_Memory\_Load long commands. Updates to the instrument memory are expected after every power-on or reset. See Section for a listing of the functional patches currently required for each instrument. The initial operational values (subject to change) are shown in

Table ‑. ICP and DAP Expected RAM Values

|  |  |  |
| --- | --- | --- |
| Instrument | ICP (Dec/Hex) | DAP (Dec/Hex) |
| PFM | 11345 (0x2C51) | 29832 (0x7488) |
| FM 1 | 59486 (0xE85E) | 11640 (0x2D78) |
| FM 2 | 36617 (0x8F09) | 45410 (0xB162) |
| FM 3 | 899 (0x383) | 62029 (0xF24D) |
| FM 4 | 21379 (0x5383) | 62029 (0xF24D) |
| FM 5 | 64467 (0xFBD3) | 62029 (0xF24D) |

DS-60 DAP/ICP ROM Code Checksum

This parameter indicates the internally computed checksum value for the DAP/ICP ROM (Read Only Memory) code. This value is based on the preprogrammed flight code and is not expected to change. It will be different for each instrument, the at-launch values are shown in . See Section for more details.

Table ‑. DAP and ICP ROM Code Checksums

|  |  |  |
| --- | --- | --- |
| Instrument | ICP (Dec/Hex) | DAP (Dec/Hex) |
| PFM | 60704 (0xED20) | 24364 (0x5F2C) |
| FM 1 | 14198 (0x3776) | 53947 (0xD2BB) |
| FM 2 | 15311 (0x3BCF) | 36400 (0x8E30) |
| FM 3 | 30153 (0x75C9) | 19224 (0x4818) |
| FM 4 | 50427 (0xC4FB) | 21231 (0x52EF) |
| FM 5 | 56217 (0xDB99) | 63122 (0xF692) |

DS-61 Azimuth Mode

This parameter indicates the configuration status of the azimuth gimbal action for the current packet. See , note . This status will generally reflect that the azimuth is going to a Goto\_X position, is performing an A\_B slewing operation, or is stopped. When the instrument is in the nominal Crosstrack mode, this parameter should indicate Goto\_Position\_Crosstrack. For the nominal Biaxial mode, this parameter should indicate Scan\_A\_B\_Asynchronously. This parameter will generally reflect the Command\_Azimuth\_Goto\_Position command upon completing execution. Upon any power up or reset conditions, this status should indicate Initialized.

DS-62 Azimuth Motion Status

This parameter indicates the motion of the azimuth gimbal as of the last sample in the current packet. See , note . Note that this parameter does NOT provide any indication of azimuth motion during the packet (i.e., stopped at the beginning of the packet and then started moving in the middle and vice-versa).

DS-63 Azimuth Direction Status

This parameter indicates the direction the azimuth gimbal was moving as of the last sample in the current packet. See , note . Whenever the gimbal is not moving, this parameter will normally indicate a forward direction. Forward direction is indicated with increasing encoder angles. This parameter does NOT provide any indication of azimuth direction during the packet (i.e., stopped or turned around at an A\_B slew point).

DS-64 Azimuth Position Status

This parameter indicates the azimuth gimbal position as of the last sample in the current packet. See , note . When the instrument is in the nominal Crosstrack mode or is performing an Alongtrack operation, this parameter should indicate At\_Goto\_Position. For the nominal Biaxial mode, this parameter should indicate In\_Motion. When the azimuth has transitioned to a A\_B start point, it should indicate At\_Scan\_Position. However, mission experience indicates that once the azimuth has reached the A-B position, it will immediately begin performing the A-B rotation, which would set this parameter to In\_Motion. Should the azimuth be commanded to stop, this parameter should indicate At\_Stopped\_Position. Upon Instrument power application, this status will indicate At\_Initial.

DS-65 Azimuth Motor Drive Status

This parameter indicates whether the azimuth gimbal is enabled or disabled as of the last sample in the current packet. See , note . The normal condition is enabled except during safing conditions when the azimuth brake is applied or caged. (Unlike ERBE, the azimuth drive enabling is not commandable via short commands.)

DS-66 Azimuth Encoder LED Status

This parameter indicates whether the LED used to read the azimuth gimbal encoder is set to a low or high power setting as of the last sample in the current packet. See , note . The normal condition is a low setting. Over time, environmental conditions are expected to degrade the LED’s optical power output which will require the power to be set to high by the SET\_AZIMUTH\_ENCODER\_LED command.

DS-67 Azimuth Stall

This parameter indicates if the azimuth gimbal has stalled during the current packet. See , note . Stalling occurs whenever the number of encoder counts exceeds the commanded count (i.e., the difference value) by the Azimuth Stall Error Threshold AND this condition has occurred for more than Azimuth Stall Count Threshold (samples). When a stall occurs, the azimuth will be internally commanded to stop and the Azimuth Mode should indicate Stop\_Azimuth. An occasional anomaly has been identified upon PFM Instrument power-up. A condition can occur where the ICP incorrectly reads the azimuth position (e.g., ~23 degrees) when it is really at the crosstrack, 180 degrees. When the Instrument is commanded to release the Brake, a "runaway" gimbal can occur that tries to move the gimbal from the start-up position to the incorrect position. The resulting very large position difference will cause this stall parameter to be set. However, the expected Stop\_Azimuth command will not be executed.

DS-68 Azimuth Stall Error Threshold -

This parameter indicates the defined count threshold for the difference between the commanded gimbal position and the actual gimbal position that would indicate a possible gimbal stall condition. The default value is 500 and can be changed with the SET\_AZIMUTH\_STALL\_

ERROR\_THRESHOLD command. When this threshold and the Azimuth Stall Count Threshold are both tripped, the azimuth gimbal will be internally commanded to stop and the stall status indicator set.

DS-69 Azimuth Stall Count Threshold -

This parameter indicates the defined threshold for the number of samples the azimuth gimbal position error exceeds the Azimuth Stall Error Threshold. The default value is 10 samples and can be changed with the SET\_AZIMUTH\_STALL\_COUNT\_THRESHOLD command. When this threshold and the Azimuth Stall Error Threshold are both tripped, the azimuth gimbal will be internally commanded to stop and the stall status indicator set.

DS-70 Brake Command Status -

This parameter indicates the last command that was sent to the brake assembly. See , note . During nominal science operations, this status should generally indicate Release. During safing operations, this status should generally indicate either apply or stop. The Fixed\_Step\_To\_Cage/Apply are expected to be used only when mechanical difficulties occur. This status parameter will reflect any changes made by the following commands: COMMAND\_BRAKE, STEP\_BRAKE\_TO\_CAGED, or STEP\_BRAKE\_TO\_APPLIED.

DS-71 Brake Motion Status -

This parameter indicates the motion of the brake assembly for the current packet as of the last sample. See , note . During nominal science operations, this status should generally indicate Stopped. During safing operations, this status generally indicates applying (going into a safing operation), releasing (going back to science operations), or stopped.

DS-72 Brake Position Status -

This parameter indicates the position of the brake assembly for the current packet as of the last sample. See , note . During nominal science operations, this status should generally indicate At\_Released\_Position. During safing operations, this status should generally indicate At\_Applied\_Position. The brake assembly is essentially a rocker arm that pivots about a center point. When one end is placed against the azimuth gimbal, the brake will be applied. When the other end is placed against the azimuth assembly, the brake will be caged (but only if the azimuth is at the predefined cage position). When neither end is placed against the azimuth assembly, the brake is in its released position.

DS-73 Brake Commanded Position -

This parameter indicates the position count value to which the brake assembly was commanded within the current packet. During nominal operations, this value will reflect one of the predefined fixed positions (typ. released or applied). During any stepping operations, this value will reflect the position commanded by the ground controller.

DS-74 Brake Current Position -

This parameter indicates the position of the brake (in counts) for the current packet as of the last sample. During normal science operations, this value should correspond to the predefined release position, plus or minus the release position margin. During safing operations, this position value should correspond to the predefined applied position, plus or minus the applied position margin.

DS-75 Brake Position SUBMUX Channel -

This parameter indicates the instruments submultiplexer channel for the current packet as of the last sample in the packet. Each channel corresponds to a given analog sensor to be sampled by the Analog to Digital Converter (ADC) and placed in the packet based on the packet format and sample number. This value is expected to be 163, the designated channel for the brake position sensor.

DS-76 Brake Step Count -

This parameter indicates the current brake position (in counts) as of the last sample in the packet. This count is active whenever the brake has been commanded to perform fixed step operations; otherwise, this value should correspond to 0.

DS-77 Brake Defined Released/Applied/Cage Position -

These parameters indicate a brake fixed released/applied/caged position setpoint. The default values for each instrument, as specified in the flight codes, are shown in below. The default values can only be changed with a ICP unique memory patch long command. (See Section for format details.)

Table ‑. Brake Default Positions (counts)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Position Setpoints | PFM | FM 1 | FM 2 | FM 3 | FM 4 | FM 5 |
| Released | 800 | 800 | 800 | 730 | 710 | 740 |
| Applied | 685 | 685 | 698 | 625 | 602 | 635 |
| Caged | 1027 | 1027 | 1027 | 955 | 962 | 989 |

DS-78 Brake Defined Released/Applied/Cage Margin -

This parameter indicates a brake fixed position allowable margin about the predefined released setpoint. Its default values are shown below and are the same for all instruments. This default value can only be changed with a ICP unique memory patch long command. (See Section for format details.)

* **Released Margin**: Default value corresponds to 50 counts
* **Applied Margin**: Default value corresponds to 5 counts
* **Cage Margin**: Default value corresponds to 5 counts

DS-79 Safehold Input A Status/B Status (TRMM Unique) -

These 2 parameters indicate if the instrument has been commanded into a safing condition by a signal sent via the spacecraft’s safehold bus A or bus B. See , note . The normal default is 0 (Normal\_Operations). The instrument will respond to this signal only if the safehold response for the A bus has been enabled.

DS-80 Safehold Response A Status/B Status (TRMM Unique) -

These 2 parameters indicate whether the instrument will respond to a safe-hold pulse on the A or the B input side. The response is set by the SET\_SAFE\_HOLD\_RESPONSE\_A or SET\_SAFE\_HOLD\_RESPONSE\_B command and responds immediately to this command. The normal default is Enable. One of the two safehold responses must be enabled at all times for safety reasons. See , note .

DS-81 Low Rate Science Transfer Status (Terra Unique) -

This parameter indicates if the low rate science transfer interface bus is enabled or disabled. See , note . The default is 0 (Enabled). This parameter reflects the LOW\_RATE\_SCIENCE\_TRANSFER\_ENABLE command.

DS-82 Safemode Signal Received (Terra Unique) -

This parameter indicates if the instrument has been commanded into a safe condition by the spacecraft’s safing interface. See , note . The normal default is 0 (Signal\_Not\_Received).

DS-83 Safemode Signal Response (Terra Unique) -

This parameter indicates if the instrument has responded to the Safemode Signal from the spacecraft safing interface by safing itself. See , note . The normal default is 1 (Enabled).

DS-84 IMOK Signal Received (Terra/S-NPP Unique) -

This parameter indicates if the instrument has received an IMOK (pronounced “I’m Ok”) signal from the spacecraft’s interface. See , note . The normal default is 0 (Signal\_Received).

DS-85 IMOK Signal Response (Terra/S-NPP Unique) -

This parameter indicates if the instrument has responded to the IMOK (pronounced “I’m Ok”) Signal Received from the spacecraft’s interface. See , note . The normal default is 1 (Enabled). This parameter reflects the SET\_IMOK\_SIGNAL\_RESPONSE command. This signal is used in conjunction with spacecraft safing conditions.

DS-86 Time Mark & Frequency Bus Select (Terra/Aqua/S-NPP Unique) -

This parameter indicates which spacecraft timing bus to use for the packet time stamp. See , note . The default is 0 (Bus\_A\_Selected). This parameter reflects the SELECT\_TIME\_MARK\_FREQUENCY\_BUS command.

DS-87 Time Mark & Frequency Interrupt (Terra/Aqua/S-NPP Unique) -

This parameter indicates a spacecraft timing bus interruption has occurred. See , note . The default is 0 (No\_Time\_Frequency\_Interrupt). This parameter reflects the SET\_TIME\_

MARK\_FREQUENCY\_RESPONSE command.

DS-88 DMA Communication Status -

This parameter indicates the status of the ICP-to-DAP DMA (Direct Memory Access) activity as of the last sample for the current packet. See , note . The DMA is under the control of the ICP and is the only mechanism for transferring commands and data between the two processors.

DS-89 SPS 1 State/SPS 2 State -

These parameters indicate if the Sun was detected on Solar Presence Sensor 1/Solar Presence Sensor 2 as of the last sample during the current packet. See , note . A Sun presence state assumes these sensors were enabled by the Set\_SPS1\_Response or the Set\_SPS2\_Response command. A Sun detected signal is used as an input by the solar avoidance algorithm for determining if the instrument should be safed due to the Sun possibly coming into the FOV of the bolometer detectors. (See - Solar Presence Sensor (SPS): on Solar Avoidance for further details.)

DS-90 SPS 1 Response/SPS 2 Response -

These parameters indicate whether the instrument will execute a SAFE mode sequence in response to a solar warning by the solar presence sensors. See , note . (See - Solar Presence Sensor (SPS): on Solar Avoidance for further details.) These parameters reflect the SET\_SPS1\_RESPONSE or SET\_SPS2\_RESPONSE commands. Default = ENABLED.

DS-91 Solar Warning -

This parameter indicates that the instrument’s solar presence sensors have confirmed the Sun is within the FOV of the sensors and that potential damage to the radiometers may result. See

, note . Should a warning occur, the instrument will automatically command the instrument to the safe mode using the safe mode internal sequence.

DS-92 Scan Time-out Response -

This parameter indicates the response the instrument will take if the elevation scan counter

reaches 0 during biaxial scanning. See , note . If the response is enabled and the counter reaches 0, the instrument will execute the Special\_Short\_Earth\_Scan mode sequence which causes the elevation gimbal to begin a short-earth scan profile. The parameter is controlled with the SET\_SCAN\_TIMEOUT\_RESPONSE command.

DS-93 Scan Time-out Counting -

This parameter indicates whether the solar avoidance scan time-out counting condition is active. See , note . Scan time-out counting will be active when the instrument is performing an azimuth biaxial scan, an elevation normal-earth scan, and the Scan Time-out Response is enabled.

DS-94 Scan Time-out Occurred -

This parameter indicates whether a solar avoidance scan time-out condition has occurred during this packet. See , note . A time-out occurs when the scan time-out counter has reached zero. Upon reaching zero, the instrument will be commanded to perform a special short-earth scan internal mode sequence. (See - Solar Presence Sensor (SPS): on Solar Avoidance for further details.)

DS-95 Solar Warning Event Sample Number -

This parameter indicates the sample number when a solar warning occurred and the instrument was commanded to a safing condition.

DS-96 Solar Warning Event Scan Period -

This parameter indicates the scan count value when a solar warning occurred and the instrument was commanded to a safing condition. (See - Solar Presence Sensor (SPS): on Solar Avoidance for further details.)

DS-97 Scan Time-out Scan Period -

This parameter indicates the scan count value when a solar avoidance time-out condition last occurred and the instrument was commanded to perform a special short-earth scan internal mode sequence. (See - Solar Presence Sensor (SPS): on Solar Avoidance for further details.)

DS-98 SPS 1/SPS 2 Threshold Noise -

These parameters indicate the count value used by the solar detection algorithm to determine a valid solar sensor detection by the wide FOV signal. The default value is 500 counts. These parameters reflect the SET\_SPS1\_THRESHOLD\_NOISE or SET\_SPS2\_THRESHOLD\_NOISE command. (See - Solar Presence Sensor (SPS): on Solar Avoidance for further details.)

DS-99 SPS 1/SPS 2 Threshold Scale Numerator -

These parameters indicate a scaling coefficient used in the solar detection algorithm (narrow FOV to wide FOV ratio). The default value is 32. This parameter reflects the SET\_SPS1\_THRESHOLD\_NUMERATOR or SET\_SPS2\_THRESHOLD\_NUMERATOR commands. (See - Solar Presence Sensor (SPS): on Solar Avoidance for further details.

DS-100 SPS 1/SPS 2 Solar Detection State -

These parameters indicate the results of the solar detection algorithm for this packet. See

, note . This status will indicate the Sun is present only when the number of valid wide FOV detections exceeds the detection count threshold. This detection algorithm operates continually. (See - Solar Presence Sensor (SPS): on Solar Avoidance for further details.)

DS-101 SPS 1/SPS 2 Solar Detection Count -

These parameters indicate the number of detections the solar detection algorithm has registered in the packet. This detection counting algorithm operates continually. Due to the incrementing/decrementing nature of this algorithm, values will most likely be seen here only if the Sun is sensed during the later samples in a packet. (See - Solar Presence Sensor (SPS): on Solar Avoidance for further details.)

DS-102 SPS 1/SPS 2 Solar Detection Count Threshold -

These parameters indicate the number of detected solar samples needed to signify a confirmed solar detection condition has occurred. (See - Solar Presence Sensor (SPS): on Solar Avoidance for further details.) The default value is 5 samples. These parameters reflect the SET\_SPS1\_THRESHOLD\_COUNT or SET\_SPS2\_THRESHOLD\_COUNT command.

DS-103 SPS 1/SPS 2 Solar Detection Max Count -

These parameters indicate the maximum number of solar detections that were registered in the current scan, regardless of the current SPS 1/SPS 2 Solar Detection Count value. Since this detection operates continuously, these parameters are useful diagnostic indicators. (See - Solar Presence Sensor (SPS): on Solar Avoidance for further details.)

DS-104 Solar Avoidance Initial Scan Count -

This parameter indicates the starting scan count to be used for scan time-out counting. The internal default is 10 scans. This will reflect the last commanded value loaded with the SET\_SCAN\_TIMEOUT\_COUNT command. The value is determined based on orbital planning aids. (See - Solar Presence Sensor (SPS): on Solar Avoidance for further details.)

DS-105 Solar Avoidance Current Scan Count -

This decrementing counter reflects the number of 6.6 second scans remaining before the instrument executes a SPECIAL\_SHORT\_EARTH\_SCAN mode sequence. The initial count value is set using the SET\_SCAN\_TIMEOUT\_COUNT command. (See - Solar Presence Sensor (SPS): on Solar Avoidance for further details.)

Digital Status Enumerations

contains the enumerated representation of the bit values for selected digital status parameters. These values are taken from DRL-64 (See Reference ) or the instrument flight code.

| Table ‑. Digital Status Enumerations | | | |
| --- | --- | --- | --- |
| Note | Digital Status Representations | Note | Digital Status Representations |
| 100 | 0 = Off  1 = On | 101 | 0 = Bridge\_Balance\_Off  1 = Bridge\_Balance\_Maintenance  2 = Bridge\_Balance\_Reset |
| 102 | 0 = DAC\_Value\_Unchanged  1 = DAC\_Value\_Changed | 103 | 0 = Off  1 = Level\_1  2 = Level\_2  3 = Level\_3 |
| 104 | 0 = Cover\_Stop  1 = Cover\_Open  2 = Cover\_Close  4 = Fixed\_Step\_To\_Open  5 = Fixed\_Step\_To\_Close | 105 | 0 = Cover\_Stopped  1 = Cover\_Opening  2 = Cover\_Closing  4 = Cover\_Stepping\_Forward  5 = Cover\_Stepping\_Reverse  15 = Cover\_Started\_Moving |
| 106 | 0 = Cover\_Not\_At\_Open\_Or\_Close  1 = Cover\_At\_Open\_Position  2 = Cover\_At\_Closed\_Position  4 = Potentially\_Failed\_Position\_Sensor | 107 | 0 = Cover\_Sensor\_1  1 = Cover\_Sensor\_2 |
| 108**\*** | 0 = Stow  1 = Normal\_Earth\_Scan  2 = Short\_Earth\_Scan  3 = MAM\_Scan  4 = Nadir\_Scan  5 = Noise\_Scan\_1  6 = Noise\_Scan\_2  7= Cal Mode 5 (Terra = Cal Mode 22)  8 = Cal Mode 6A (Terra = Cal Mode 20A)  9 = Cal Mode 6B  10 = Cal Mode 7  11 = Cal Mode 8A  12 = Cal Mode 8B  13 = Cal Mode 11 (Terra = Cal Mode 9A)  14 = Cal Mode 12  15 = Cal Mode 14 | 109 | 0 = Normal\_Scan\_Operation  1 = Initialization\_In\_Progess  2 = At\_Initialized\_Position  3 = Scan\_Abort\_In\_Progress  4 = Elevation\_At\_Aborted\_Position |
| 110 | 0 = Low  1 = High | 111 | 0 = Goto\_Position\_Crosstrack  1 = Goto\_Position\_A  2 = Goto\_Position\_B  3 = Goto\_Position\_Solar\_Cal  4 = Goto\_Position\_Caged  5 = Goto\_Position\_Spare\_1  6 = Goto\_Position\_Spare\_2  7 = Goto\_Position\_Spare\_3  8 = Scan\_A\_B\_Asynchronously  9 = Scan\_A\_B\_Synchronously  10 = Stop\_Azimuth  15 = Initialize |
| 112 | 0 = Stopped  1 = Moving | 113 | 0 = Forward  1 = Backward (Reverse) |
| 114 | 0 = At\_Goto\_Position  1 = At\_Stopped\_Position  2 = At\_Initial\_Position  3 = At\_Scan\_Position  4 = In\_Motion | 115 | 0 = Disabled  1 = Enabled |
| 116 | 0 = Stop  1 = Cage  2 = Apply  3 = Release  4 = Fixed\_Step\_To\_Cage  5 = Fixed\_Step\_To\_Apply | 117 | 0 = Stopped  1 = Caging  2 = Applying  3 = Releasing  4 = Forward\_Stepping  5 = Reverse\_Stepping  15 = Started\_Moving |
| 118 | 0 = Not\_At\_Release\_Applied\_Or\_Caged  1 = At\_Caged\_Position  2 = At\_Applied\_Position  3 = At\_Released\_Position  4 = Potentially\_Failed\_Position\_Sensor | 119 | 0 = Normal\_Science\_Data  1 = Calibration\_Data  2 = Memory\_Dump\_Data  3 = Gimbal\_Data  4 = Execution\_Time\_Data  5 = No\_Archive\_Data  6 = Fixed\_Pattern\_Data |
| 120 | 0 = FTM  1 = PFM (TRMM)  2 = FM 1 (Terra FORE)  3 = FM 2 (Terra AFT)  4 = FM 3 (Aqua FORE)  5 = FM 4 (Aqua AFT)  6 = FM 5 (S-NPP)  7 = FM 6 (reserved) | 121 | 0 = SpaceCraft\_Timing  1 = Instrument\_Timing |
| 122**\*** | 0 = Safe\_Mode  1 = Standby\_Mode  2 = Crosstrack\_Mode  3 = Biaxial\_Mode  4 = Solar\_Calibration\_Mode  5 = Diagnostic\_Config\_Mode  6 = Internal\_Calibration\_Mode  7 = Special\_Short\_Scan\_Mode  8 = Contamination\_Safe\_Mode  9 = Hold\_Mode  10 = Abbrev\_Internal\_Cal\_Mode  11 = Internal Sequence 11 (Reserved)  12 = Internal Sequence 12 (Reserved)  13 = Internal Sequence 13 (Reserved)  14 = Internal Sequence 14 (Reserved)  15 = Internal Sequence 15 (Reserved) | 123 | 0 = Command  1 = Safehold  2 = Solar\_Avoidance  3 = Scan\_Timeout |
| 124 | 0 = Executing\_Sequence  1 = Waiting\_For\_Next\_Scan  2 = Waiting\_For\_Azimuth  3 = Sequence\_Complete | 125 | 0 = Normal\_Operation  1 = Spacecraft\_Safehold |
| 126 | 0 = Response\_Disabled  1 = Response\_Enabled | 127 | 0 = Normal\_Reset (Not By Timeout)  1 = Watchdog\_Reset (By Timeout) |
| 128 | 0 = Enabled (Timer Disarmed)  1 = Disabled (Timer Armed) | 129 | 0 = On  1 = Off |
| 130 | 0 = Sun\_Not\_Present  1 = Sun\_Present | 131 | 0 = SPS\_Response\_Disabled  1 = SPS\_Response\_Enabled |
| 132 | 0 = Sun\_Not\_Detected  1 = Sun\_Detected | 133 | 0 = No\_Solar\_Warning  1 = Solar\_Warning |
| 134 | 0 = Timeout\_Response\_Disabled  1 = Timeout\_Response\_Enabled | 135 | 0 = Scan\_Timeout\_Not\_Active  1 = Scan\_Timeout\_Active |
| 136 | 0 = Not\_Stalled  1 = Stalled | 137 | 0 = Flag\_Not\_Set  1 = Flag\_Set |
| 138 | 0 = DMA\_Communication\_Ok  1 = DMA\_Transmit\_Timed\_Out  2 = DMA\_Receive\_Timed\_Out  3 = Sample\_Numbers\_Not\_Sync | 139 | 0 = Cmd\_Accepted  1 = Cmd\_Not\_Used  2 = Cmd\_Index\_Out\_Of\_Range  3 = Cmd\_Parameter\_Out\_Of\_Range  4 = Cmd\_Not\_A\_Valid\_Short\_Command  5 = Cmd\_Not\_A\_Valid\_Long\_Command  6 = Cmd\_Had\_A\_Incorrect\_Checksum  7 = Cmd\_Exceeded\_Mode\_Index  8 = Cmd\_UnAccepted\_In\_Current\_Mode  9 = Cmd\_UnAccepted\_During\_Seq\_Exec  10 = Cant\_Use\_Brake\_While\_Az\_Moving  11 = Cant\_Cage\_Az\_In\_Current\_Pos  12 = Cant\_Move\_Az\_Brake\_Unreleased  13 = Req\_Mode\_Invalid\_In\_Curr\_Mode  14 = Pos\_A\_Must\_Be\_Less\_Than\_Pos\_B |
| 140 | 0 = Spacecraft  1 = Internal\_Sequence | 141**\*** | 0 = No\_Error  1 = Unexpected\_Interrupt  2 = Illegal\_Int\_Seq\_Control\_Value  3 = Process\_Short\_Cmd\_Illegal\_Cmd  4 = Process\_Long\_Cmd\_Illegal\_Cmd  5 = Checksum\_Illegal\_Command  6 = Received\_1553\_Message\_With\_Err  7 = Incorrect\_Initial\_DMA\_Syncs  8 = PackData\_Illegal\_Data\_Indictr  9 = Int\_Seq\_Index\_Limit\_Exceeded  10 = Failed\_At\_Least\_One\_DAA\_Comm  11 = Illegal\_HK\_Destination\_Size  12 = Spurious\_DAP\_Sample\_Clk\_Intrpt  13 = Spurious\_ICP\_Sample\_Clk\_Intrpt  14 = ICP\_got\_to\_DMA\_Transfer\_Late  20 = Potential\_Failed\_Brake\_Sensor  21 = Potential\_Failed\_Cover\_Sensor  22 = MainCover\_Allowed\_Lag\_Exceeded  23 = Pckt\_Transfer\_Lockup\_Detected  24 = DAA\_ICA\_Sample\_Nums\_Mismatch  25 = DAA\_Reset\_via\_Contin\_Comm\_Fail  26 = EOSAM\_Improper\_SafeMode\_Value  26 = EOSPM\_Science\_Packet\_Xfer\_Ok  50 = ICP\_Detected\_False\_1553\_Msg  63 = Undefined\_Instrument\_Cmd\_Err |
| 142 | 0 = No\_Scan\_Timeout  1 = Scan\_Timeout\_Occurred | 143 | 0 = Response\_Disabled  1 = Response\_Enabled |
| 144 | 0 = Signal\_Not\_Received  1 = Signal\_Received | 145 | 0 = Signal\_Received  1 = Signal\_Not\_Received |
| 146 | 0 = Bus\_A\_Selected  1 = Bus\_B\_Selected | 147 | 0 = No\_Time\_Freq\_Interupt  1 = Time\_Freq\_Interupt\_Occurred |
| **\*** Exact denotations varies by spacecraft. | | | |

CERES Instrument Commands

contains the enumerated representation of the bit values for the instrument digital status command parameters. These values are taken from DRL-64 (See Reference ) or the instrument flight code.

| Table ‑. CERES Instrument Command Enumerations | | | |
| --- | --- | --- | --- |
| Link | Main Command Description | Main Value  (Dec(Hex)) | Parameter Index Values |
| [ICP COMMANDS] | | | |
| ICE-1 | No\_Command\_ICP | 0 | N/A |
|  | Command\_Azimuth\_Goto\_Position | 256  (100) | 0 = Command\_Azimuth\_Goto\_Crosstrack  1 = Command\_Azimuth\_Goto\_Position\_A  2 = Command\_Azimuth\_Goto\_Position\_B  3 = Command\_Azimuth\_Goto\_SolarCal  4 = Command\_Azimuth\_Goto\_Cage  5 = Command\_Azimuth\_Goto\_Spare\_1  6 = Command\_Azimuth\_Goto\_Contam  7 = Command\_Azimuth\_Goto\_Spare\_3  8 = Command\_Azimuth\_Scan\_AB\_Async  9 = Command\_Azimuth\_Scan\_AB\_Sync  10 = Command\_Azimuth\_To\_Stop |
|  | Set\_Azimuth\_Fixed\_Crosstrack | 512 (200) | 0 .. 65535 = Fixed Raw Azimuth Position |
|  | Set\_Azimuth\_Fixed\_Position\_A | 513 (201) | 0 .. 65535 = Fixed Raw Azimuth Position |
|  | Set\_Azimuth\_Fixed\_Position\_B | 514 (202) | 0 .. 65535 = Fixed Raw Azimuth Position |
|  | Set\_Azimuth\_Fixed\_SolarCal | 515 (203) | 0 .. 65535 = Fixed Raw Azimuth Position |
|  | Set\_Azimuth\_Fixed\_Caged | 516 (204) | 0 .. 65535 = Fixed Raw Azimuth Position |
|  | Set\_Azimuth\_Fixed\_Spare\_1 | 517 (205) | 0 .. 65535 = Fixed Raw Azimuth Position |
|  | Set\_Azimuth\_Fixed\_Spare\_2 | 518 (206) | 0 .. 65535 = Fixed Raw Azimuth Position |
|  | Set\_Azimuth\_Fixed\_Spare\_3 | 519 (207) | 0 .. 65535 = Fixed Raw Azimuth Position |
|  | Set\_Azimuth\_Rate\_Goto\_Rate | 768 (300) | 1371 = Fixed Raw Azimuth Rate (Typ.) |
|  | Set\_Azimuth\_Rate\_Async\_Rate | 769 (301) | 1096 = Fixed Raw Azimuth Rate (Typ.) |
|  | Set\_Azimuth\_Rate\_Sync\_Rate | 770 (302) | 913 = Fixed Raw Azimuth Rate (Typ.) |
|  | Command\_Brake(1) | 1024  (400) | 0 = Command\_Brake\_Stop  1 = Command\_Brake\_Cage  2 = Command\_Brake\_Apply  3 = Command\_Brake\_Release |
|  | Step\_Brake\_To\_Caged | 1280 (500) | 0 .. 1000 (Typ.) |
|  | Step\_Brake\_To\_Applied | 1536 (600) | 0 .. 1000 (Typ.) |
|  | Set\_Instrument\_Mode | 4096  (1000) | 0 = Set\_Mode\_Safe  1 = Set\_Mode\_Standby  2 = Set\_Mode\_Crosstrack  3 = Set\_Mode\_Biaxial  4 = Set\_Mode\_Solar\_Cal  5 = Set\_Mode\_Diagnostic  6 = Set\_Mode\_Internal\_Cal  7 = Set\_Mode\_Spec\_Short\_Scan  8 = Set\_Mode\_Contam\_Safe  9 = Set\_Mode\_Hold  10 = Set\_Mode\_Abbrev\_Int\_Cal  11 = Set\_Mode\_Int\_Seq\_11  12 = Set\_Mode\_Int\_Seq\_12  13 = Set\_Mode\_Int\_Seq\_13  14 = Set\_Mode\_Int\_Seq\_14  15 = Set\_Mode\_Int\_Seq\_15 |
|  | Set\_Safehold\_Response\_A  (TRMM Command) | 4352  (1100) | 0 = Set\_Safehold\_Response\_A\_Disabled  1 = Set\_Safehold\_Response\_A\_Enabled |
|  | Set\_Safehold\_Response\_B  (TRMM Command) | 4353  (1101) | 0 = Set\_Safehold\_Response\_B\_Disabled  1 = Set\_Safehold\_Response\_B\_Enabled |
|  | Set\_SPS1\_Response | 46081  (1200) | 0 = Set\_SPS1\_Response\_Disabled  1 = Set\_SPS1\_Response\_Enabled |
|  | Set\_SPS2\_Response | 46091  (1201) | 0 = Set\_SPS2\_Response\_Disabled  1 = Set\_SPS2\_Response\_Enabled |
|  | Set\_SPS1\_Threshold\_Noise | 4864 (1300) | 0 .. 4095 (Typ.) |
|  | Set\_SPS2\_Threshold\_Noise | 4865 (1301) | 0 .. 4095 (Typ.) |
|  | Set\_SPS1\_Threshold\_Numerator | 5120 (1400) | 0 .. 63 (Typ.) |
|  | Set\_SPS2\_Threshold\_Numerator | 5121 (1401) | 0 .. 63 (Typ.) |
|  | Set\_SPS1\_Threshold\_Count | 5376 (1500) | 0 .. 55 (Typ.) |
|  | Set\_SPS2\_Threshold\_Count | 5377 (1501) | 0 .. 55 (Typ.) |
|  | Set\_Scan\_Timeout\_Response | 56321  (1600) | 0 = Set\_Scan\_Timeout\_Response\_Disabled  1 = Set\_Scan\_Timeout\_Response\_Enabled |
|  | Set\_Scan\_Timeout\_Count | 5888 (1700) | 0 .. 1000 (Typ.) |
|  | Set\_Quicklook\_Flag | 64001  (1900) | 0 = Set\_Quicklook\_Flag\_Normal  1 = Set\_Quicklook\_Flag\_Quicklook |
|  | Select\_Time\_Mark\_Frequency\_Bus  (Terra/Aqua/S-NPP Command) | 6656  (1A00) | 0 = Bus A  1 = Bus B |
|  | Set\_Time\_Mark\_Interrupt\_Response  (Terra/Aqua/S-NPP Command) | 6912  (1B00) | 0 = Response\_Disabled  1 = Response\_Enabled |
|  | Set\_IMOK\_Signal\_Response  (Terra/S-NPP Command) | 7168  (1C00) | 0 = Response\_Disabled  1 = Response\_Enabled |
|  | Set\_Watchdog\_Timer\_ICP | 7680  (1E00) | 0 = Set\_Watchdog\_Timer\_ICP\_Disarm  1 = Set\_Watchdog\_Timer\_ICP\_Arm |
|  | Set\_PROM\_Power\_ICP | 7936  (1F00) | 0 = Set\_PROM\_Power\_ICP\_On  1 = Set\_PROM\_Power\_ICP\_Off |
|  | Set\_Mem\_Dump\_Start\_Offset\_ICP | 8192 (2000) | 0 .. 65535 |
|  | Set\_Mem\_Dump\_Start\_Segment\_ICP | 8448 (2100) | 0 .. 65535 |
|  | Set\_Mem\_Dump\_End\_Offset\_ICP | 8704 (2200) | 0 .. 65535 |
|  | Set\_Mem\_Dump\_End\_Segment\_ICP | 8960 (2300) | 0 .. 65535 |
|  | Set\_Azimuth\_Encoder\_LED | 9728  (2600) | 0 = Set\_Azimuth\_Encoder\_LED\_Low  1 = Set\_Azimuth\_Encoder\_LED\_High |
|  | Set\_Azimuth\_Offset\_Correction | 9984 (2700) | 0 .. 65535 |
|  | Set\_Azimuth\_Stall\_Error\_Thres | 10240 (2800) | 0 .. 65535 |
|  | Set\_Azimuth\_Stall\_Count\_Thres | 10496 (2900) | 0 .. 659 (References number of samples) |
|  | Set\_Packet\_Data\_Type | 12288  (3000) | 0 = Set\_Packet\_Data\_Type\_Normal  1 = Set\_Packet\_Data\_Type\_Cal  2 = Set\_Packet\_Data\_Type\_Mem  3 = Set\_Packet\_Data\_Type\_Gimbal  4 = Set\_Packet\_Data\_Type\_Execution  5 = Set\_Packet\_Data\_Type\_Noarchive  6 = Set\_Packet\_Data\_Type\_Fixed |
|  | Low\_Rate\_Science\_Transfer\_Enable  (Terra Command) | 12544  (3100) | 0 = Transfer\_Enabled  1 = Transfer\_Disabled |
|  | EOSAM\_Load\_Initiate  (Terra Command) | 16128  (3F00) | 0 = No\_Action  1 = Load |
| [DAP COMMANDS] | | | |
| ICE-1 | No\_Command\_DAP | 16384 (4000) | N/A |
|  | Set\_Scan\_Mode | 16640  (4100) | 0 = Set\_Scan\_Mode\_Stow  1 = Set\_Scan\_Mode\_Normal\_Earth  2 = Set\_Scan\_Mode\_Short\_Earth  3 = Set\_Scan\_Mode\_MAM\_Scan  4 = Set\_Scan\_Mode\_Nadir\_Scan  5 = Set\_Scan\_Mode\_Noise\_Test\_1  6 = Set\_Scan\_Mode\_Noise\_Test\_2  7 = Set\_Scan\_Mode\_Cal\_Mode\_5  8 = Set\_Scan\_Mode\_Cal\_Mode\_6A  9 = Set\_Scan\_Mode\_Cal\_Mode\_6B  10 = Set\_Scan\_Mode\_Cal\_Mode\_7  11 = Set\_Scan\_Mode\_Cal\_Mode\_8A  12 = Set\_Scan\_Mode\_Cal\_Mode\_8B  13 = Set\_Scan\_Mode\_Cal\_Mode\_11  14 = Set\_Scan\_Mode\_Cal\_Mode\_12  15 = Set\_Scan\_Mode\_Cal\_Mode\_14 |
|  | Command\_Cover\_Main | 16896  (4200) | 0 = Command\_Cover\_Main\_Stop  1 = Command\_Cover\_Main\_Open  2 = Command\_Cover\_Main\_Close  3 = Command\_Cover\_Main\_Unused |
|  | Command\_Cover\_MAM | 16897  (4201) | 0 = Command\_Cover\_MAM\_Stop  1 = Command\_Cover\_MAM\_Open  2 = Command\_Cover\_MAM\_Close  3 = Command\_Cover\_MAM\_Unused |
|  | Set\_SWICS\_Intensity | 17152  (4300) | 0 = Set\_SWICS\_Intensity\_Off  1 = Set\_SWICS\_Intensity\_Level\_1  2 = Set\_SWICS\_Intensity\_Level\_2  3 = Set\_SWICS\_Intensity\_Level\_3 |
|  | Set\_Blackbody\_Temp\_Setpoint | 17408 (4400) | 0 .. 4095 |
|  | Set\_Blackbody\_Temp\_Control | 17664  (4500) | 0 = Set\_Blackbody\_Temp\_Control\_Off  1 = Set\_Blackbody\_Temp\_Control\_On |
|  | Set\_TOT\_Brid\_Bal\_Coarse\_DAC\_Val | 17920 (4600) | 0 .. 4095 |
|  | Set\_SW\_Brid\_Bal\_Coarse\_DAC\_Val | 17921 (4601) | 0 .. 4095 |
|  | Set\_WN\_Brid\_Bal\_Coarse\_DAC\_Val | 17922 (4602) | 0 .. 4095 |
|  | Set\_TOT\_Brid\_Bal\_Fine\_DAC\_Val | 18176 (4700) | 0 .. 4095 |
|  | Set\_SW\_Brid\_Bal\_Fine\_DAC\_Val | 18177 (4701) | 0 .. 4095 |
|  | Set\_WN\_Brid\_Bal\_Fine\_DAC\_Val | 18178 (4702) | 0 .. 4095 |
|  | Set\_TOT\_Brid\_Bal\_Control\_Mode | 18432  (4800) | 0 = Set\_TOT\_Brid\_Bal\_Control\_Mode\_Off  1 = Set\_TOT\_Brid\_Bal\_Control\_Mode\_On |
|  | Set\_SW\_Brid\_Bal\_Control\_Mode | 18433  (4801) | 0 = Set\_SW\_Brid\_Bal\_Control\_Mode\_Off  1 = Set\_SW\_Brid\_Bal\_Control\_Mode\_On |
|  | Set\_WN\_Brid\_Bal\_Control\_Mode | 18434  (4802) | 0 = Set\_WN\_Brid\_Bal\_Control\_Mode\_Off  1 = Set\_WN\_Brid\_Bal\_Control\_Mode\_On |
|  | Set\_TOT\_Sensor\_Temp\_Setpoint | 18688 (4900) | 0 .. 4095 |
|  | Set\_SW\_Sensor\_Temp\_Setpoint | 18689 (4901) | 0 .. 4095 |
|  | Set\_WN\_Sensor\_Temp\_Setpoint | 18690 (4902) | 0 .. 4095 |
|  | Set\_TOT\_Sensor\_Temp\_Control | 18944  (4A00) | 0 = Set\_TOT\_Sensor\_Temp\_Control\_Off  1 = Set\_TOT\_Sensor\_Temp\_Control\_On |
|  | Set\_SW\_Sensor\_Temp\_Control | 18945  (4A01) | 0 = Set\_SW\_Sensor\_Temp\_Control\_Off  1 = Set\_SW\_Sensor\_Temp\_Control\_On |
|  | Set\_WN\_Sensor\_Temp\_Control | 18946  (4A02) | 0 = Set\_WN\_Sensor\_Temp\_Control\_Off  1 = Set\_WN\_Sensor\_Temp\_Control\_On |
|  | Set\_TOT\_Sensor\_Temp\_Coef\_A0 | 19200 (4B00) | -32768 .. 32767 |
|  | Set\_SW\_Sensor\_Temp\_Coef\_A0 | 19201 (4B01) | -32768 .. 32767 |
|  | Set\_WN\_Sensor\_Temp\_Coef\_A0 | 19202 (4B02) | -32768 .. 32767 |
|  | Set\_TOT\_Sensor\_Temp\_Coef\_A1 | 19456 (4C00) | -32768 .. 32767 |
|  | Set\_SW\_Sensor\_Temp\_Coef\_A1 | 19457 (4C01) | -32768 .. 32767 |
|  | Set\_WN\_Sensor\_Temp\_Coef\_A1 | 19458 (RC02) | -32768 .. 32767 |
|  | Set\_TOT\_Sensor\_Temp\_Coef\_B1 | 19712 (4D00) | -32768 .. 32767 |
|  | Set\_SW\_Sensor\_Temp\_Coef\_B1 | 19713 (4D01) | -32768 .. 32767 |
|  | Set\_WN\_Sensor\_Temp\_Coef\_B1 | 19714 (4D02) | -32768 .. 32767 |
|  | Set\_TOT\_Sensor\_Temp\_Coef\_D0 | 19968 (4E00) | -32768 .. 32767 |
|  | Set\_SW\_Sensor\_Temp\_Coef\_D0 | 19969 (4E01) | -32768 .. 32767 |
|  | Set\_WN\_Sensor\_Temp\_Coef\_D0 | 19970 (4E02) | -32768 .. 32767 |
|  | Set\_Main\_Cover\_Active\_Pos\_Sensor | 20480  (5000) | 0 = Set\_Main\_Cover\_Active\_Pos\_Sensor\_1  1 = Set\_Main\_Cover\_Active\_Pos\_Sensor\_2 |
|  | Step\_Main\_Cover\_To\_Open | 20736 (5100) | 0 .. 65535 |
|  | Step\_MAM\_Cover\_To\_Open | 20737 (5101) | 0 .. 65535 |
|  | Step\_Main\_Cover\_To\_Closed | 20992 (5200) | 0 .. 65535 |
|  | Step\_MAM\_Cover\_To\_Closed | 20993 (5201) | 0 .. 65535 |
|  | Set\_Main\_Cover\_Sensor\_1\_Lag\_Error | 21248 (5300) | 0 .. 255 |
|  | Set\_Main\_Cover\_Sensor\_2\_Lag\_Error | 21249 (5301) | 0 .. 255 |
|  | Set\_Submux\_Control | 23040  (5A00) | 0 = Set\_Submux\_Control\_Table  1 = Set\_Submux\_Control\_Fixed\_Channel |
|  | Set\_Submux\_Fixed\_Channel | 23296 (5B00) | 0 .. 255 |
|  | Set\_Elevation\_Stow\_Pos | 23552 (5C00) | 0 .. 65535 |
|  | Set\_Watchdog\_Timer\_DAP | 24064  (5E00) | 0 = Set\_Watchdog\_Timer\_DAP\_Disarm  1 = Set\_Watchdog\_Timer\_DAP\_Arm |
|  | Set\_PROM\_Power\_DAP | 24320  (5F00) | 0 = Set\_PROM\_Power\_DAP\_On  1 = Set\_PROM\_Power\_DAP\_Off |
|  | Set\_Mem\_Dump\_Start\_Offset\_DAP | 24576 (6000) | 0 .. 65535 |
|  | Set\_Mem\_Dump\_Start\_Segment\_DAP | 24832 (6100) | 0 .. 65535 |
|  | Set\_Mem\_Dump\_End\_Offset\_DAP | 25088 (6200) | 0 .. 65535 |
|  | Set\_Mem\_Dump\_End\_Segment\_DAP | 25344 (6300) | 0 .. 65535 |
|  | Set\_Elevation\_Encoder\_LED | 26112  (6600) | 0 = Set\_Elevation\_Encoder\_LED\_Low  1 = Set\_Elevation\_Encoder\_LED\_High |
|  | Set\_Elevation\_Offset\_Correction | 26368 (6700) | 0 .. 65535 |
|  | Set\_Elevation\_Stall\_Error\_Thres | 26624 (6800) | 0 .. 65535 |
|  | Set\_Elevation\_Stall\_Count\_Thres | 26880 (6900) | 0 .. 659 (References no. of samples) |
| [LONG COMMANDS] | | | |
|  | ICP\_Memory\_Load | 37120 (9100) | See Command ID for Format |
|  | ICP\_Sequence\_Table\_Load | 41472 (A200) | See Command ID for Format |
|  | ICP\_Unique\_Data\_Load | 42240 (A500) | See Command ID for Format |
|  | DAP\_Memory\_Load | 53504 (D100) | See Command ID for Format |
|  | DAP\_Unique\_Data\_Load | 58624 (E500) | See Command ID for Format |
|  | DAP\_Scan\_Table\_Load | 62208 (F300) | See Command ID for Format |
| (1) To identify the enumerated desciption of this Main Command, both the Main and Parameter Values to be checked.  (2) For all instruments, these parameter values require an additional offset correction. See description for further details.  (3) See description for modification requirements to these parameter values. | | | |

**COMMAND DESCRIPTIONS (Referenced by entries in the Link Column)**

The following descriptions reference the commands (summarized in ).that are available for operating the CERES instrument. Commands are used by the on-board microprocessors to perform specific activities. Most of the commands are available for the CERES instrument on the TRMM spacecraft. Instruments on the Terra, Aqua, and S-NPP spacecraft have additional commands related to the spacecraft interface. (Commands involving the TRMM interface are retained but are ignored.)

The commands are typically categorized into either short or long commands. Short commands typically execute a single activity based on the encoded command instructions. Short commands can also execute multiple activities in the form of internal mode sequences. Internal mode sequences can be thought of as macros consisting of one or more short commands. Example short command activities include setting an algorithm variable, executing a specific mechanical motion, or initiating an internal mode sequence. Except for the SAFE mode sequence, NO sequence will be executed if an internal sequence is currently being executed. For a detailed listing of the internal mode sequence short commands, refer to Reference (DRL-87).

There are six commands that are referred to as long commands. These commands are typically used for non-routine maintenance of the flight software and attendant tables (See Section ).

Commands can be received, evaluated, and executed at a rate of one command per 0.01 second sample, subject to various operational, event, and timing constraints. For mission operational simplicity, most commands are issued to the instrument at a rate of no faster then one command per second. Some commands (e.g., internal mode sequence commands) have additional delay times. The acceptance or rejection of commands is based on an internal look-up table (See ). On-orbit operations may modify the internal look-up criteria for some commands. The acceptance and execution of internal mode sequence commands require an additional check against an allowable sequence look-up (mask) table (See ). The short commands within an internal mode sequence command have certain timing constraints to allow for gimbal operation delays. These constraints are listed below.

* Execute\_Absolute\_Time
* Execute\_ASAP
* Synchronize\_To\_Start\_Of\_Scan\_Period
* Synchronize\_To\_Azimuth\_At\_Goto\_Pos
* Synchronize\_To\_Azimuth\_Between\_A\_and\_B

ICE-1 No\_Command\_ICP/DAP -

The commands that are reserved for internal usage only.

ICE-2 Command\_Azimuth\_Goto\_Position -

The command to direct the azimuth gimbal assembly to move to a predefined GOTO position specified by the parameter index value. The motion will slew based on the defined Normal\_Slew\_Rate. [For safety, no motion will occur if the brake is not in the released position and will cause this command to be rejected.]

ICE-3 Set\_Azimuth\_Fixed\_Crosstrack/Position\_A/Position\_B -

The commands to change either the internal predefined azimuth crosstrack gimbal position, the internal predefined azimuth biaxal start position (A), or the internal predefined azimuth biaxal end position (B) gimbal position to a count value specified by the corresponding parameter index value. This command will execute immediately upon receipt, subject to any restrictions. For safety, the defined position A must always be less than defined position B.

Note: For FM 1 and FM 2, there is an extra correction "bias" count value that has to be accounted for when setting the corresponding parameter index value with this command. The engineering unit-to-count conversion equation is: Counts = Degrees - Offset. The counts-to-engineering unit conversion becomes: Degrees = Counts + Offset. The offset values are provided by TRW and is shown in .

Table ‑. Azimuth Offset Compensating Bias Count Values

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| PFM | FM 1 | FM 2 | FM 3 | FM 4 | FM 5 |
| 0 | 27 | -18 | 0 | 0 | 0 |

CAUTION: Executing this command while the azimuth gimbal is moving could cause damage to the instrument. For example, if the user changes A position from 90 to 110 degrees when the azimuth was currently in between these two values and moving towards the A position, then the gimbal will continue moving and ram into the hard stop!

ICE-4 Set\_Azimuth\_Fixed\_SolarCal/Set\_Azimuth\_Fixed\_Caged -

The commands to change either the internal predefined azimuth solar calibration gimbal position or the internal predefined azimuth cage gimbal position to count values specified by the corresponding parameter index value.

Note: For FM 1 and FM 2, there is an extra correction "bias" count value that has to be accounted for when setting the corresponding parameter index value with the Set\_Azimuth\_Fixed\_SolarCal command. The engineering unit-to-count conversion equation is: Counts = Degrees - Offset. The counts-to-engineering unit conversion becomes: Degrees = Counts + Offset. The offset values are provided by TRW and is shown in .

ICE-5 Set\_Azimuth\_Fixed\_Spare\_1/Spare\_2/Spare\_3 -

The commands to change the internal predefined azimuth spare 1, 2, or 3 gimbal positions to a count value specified by the parameter index value. The Set\_Azimuth\_Fixed\_Spare\_2 command is intended to be used in conjunction with the Contamination\_Safe mode sequence.

ICE-6 Set\_Azimuth\_Rate\_Goto\_Rate -

The command to change the internal predefined azimuth gimbal slewing rate to a count value specified by the parameter index value. The index value is derived based on the rate (in deg/sec) conversion Algorithm This command is used primarily for changing the slew rate for any non-biaxial slewing conditions (e.g., GOTO, Initialization, etc.). Note that the default goto rate for each instrument varies as shown in . It is not known at this time if the default values for FM 3 and FM 4 will be changed.

Table ‑. Default Azimuth Goto Slew Rates (Deg/Sec)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| PFM | FM 1 | FM 2 | FM 3 | FM 4 | FM 5 |
| 6.0 | 6.0 | 6.0 | 5.0 | 5.0 | 6.0 |

ICE-7 Set\_Azimuth\_Rate\_Async\_Rate/Sync\_Rate -

The commands to change the internal predefined azimuth gimbal biaxial asynchronous/synchronous slewing rate to a count value specified by the parameter index value. The index value is derived based on the rate (deg/sec) conversion Algorithm. The Set\_Azimuth\_Rate\_Async\_Rate command is used to change the default async rate (5 deg/sec) to 6 deg/sec upon power initialization or instrument resets. Note that for FM 3 and Fm4, the default rate has been changed to the expected rate. For reference, the default values are shown in .

Table ‑. Default Azimuth Async Slew Rates (Deg/Sec)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| PFM | FM 1 | FM 2 | FM 3 | FM 4 | FM 5 |
| 5.0 | 5.0 | 5.0 | 6.0 | 6.0 | 6.0 |

ICE-8 Command\_Brake -

The command to direct the brake to an applied, caged, or released position or to stop its motion. Continuous motion will proceed until the brake reaches its destination or stalls. For safety, this command will be rejected if the azimuth gimbal is moving.

ICE-9 Step\_Brake\_To\_Caged/Step\_Brake\_To\_Applied -

The commands to direct the brake to move towards the cage/applied position the number of counts specified by the parameter index value. These commands are not normally used unless there are mechanical problems (e.g., stalls) and are a means for providing controlled motion. Normally these commands would be expected to be issued by ground operators during real-time contacts. WARNING: No action should be taken if the azimuth gimbal is moving, but there are no preventive interlocks.

ICE-10 Set\_Instrument\_Mode -

The command to initiate an internal mode sequence specified by the parameter index value. Mode sequences can be thought of as command macros. A macro consists of a sequence of short commands, but can include calls to activate other sequence modes (e.g., "return to previous seq" and "goto standby"). This is the primary command for operating the instrument for most mission operations. This command will be executed based on an internal mode lockout table (See ).

ICE-11 Set\_Safehold\_Response\_A/B -

The command to select which of the two spacecraft low-power indicator buses to respond to for safing operations. The default is bus A. (For Terra, this command is not recognized and is defaulted to Set\_Safehold\_Response\_A.)

ICE-12 Set\_SPS1/2\_Response -

The commands to enable or disable solar warning actions. Even if disabled, solar presence sensor detection operations will continue.

ICE-13 Set\_SPS1/2\_Threshold\_Noise -

The commands to change the count value used by the solar detection algorithm to determine a valid solar sensor detection by the wide FOV signal. (See - Solar Presence Sensor (SPS): on Solar Avoidance for further details.)

ICE-14 Set\_SPS1/2\_Threshold\_Numerator -

The commands to change the scaling coefficient used in the solar detection algorithm (narrow FOV to wide FOV ratio). The default value is 32. (See - Solar Presence Sensor (SPS): on Solar Avoidance for further details.

ICE-15 Set\_SPS1/2\_Threshold\_Count -

The commands to change the number of detected solar samples needed to signify a confirmed solar detection condition occurrence. (See - Solar Presence Sensor (SPS): on Solar Avoidance for further details.)

ICE-16 Set\_Scan\_Timeout\_Response -

The command to enable or disable the scan time-out operations.

ICE-17 Set\_Scan\_Timeout\_Count -

The command to set the starting scan time-out packet (scan) counter to the corresponding command index value. This command is used as part of a secondary solar avoidance procedure that will command the elevation gimbal to the short-earth scan profile for any biaxial operations prior to sunrise or sunset events. (See - Solar Presence Sensor (SPS): on Solar Avoidance for further details.)

ICE-18 Set\_Quicklook\_Flag -

The command to set the quicklook status flag in the telemetry science packet based on the parameter index value. See instrument status parameters in for further description.

ICE-19 Select\_Time\_Mark\_Frequency\_Bus (Terra/Aqua/S-NPP Only) -

The command to select which of the two spacecraft buses it is to use for obtaining the time stamp information. The default is Bus\_A, where Bus\_B is for redundancy.

ICE-20 Set\_Time\_Mark\_Interrupt\_Response (Terra/Aqua/S-NPP Only) -

The command to enable or disable interrupt responses to the signal from the spacecraft time and frequency reference buses. The default is enabled.

ICE-21 Set\_IMOK\_Signal\_Response (Terra/S-NPP Only) -

The command to allow responds to the spacecraft IMOK (pronounced “I’m Ok”) signal. The flight software initializes with the IMOK disabled. When enabled, the instrument will safe itself when the IMOK signal is not received in the appropriate time.

ICE-22 Set\_Watchdog\_Timer\_ICP/DAP -

The command to arm or disarm the internal microprocessor watchdog timer. The timer should always be armed as this is an important instrument safety feature.

ICE-23 Set\_PROM\_Power\_ICP/DAP -

The command to activate the PROM chip for memory dump access. The default is OFF.

ICE-24 Set\_Mem\_Dump\_Start\_Offset\_ICP/DAP/Segment-ICP/DAP -

The commands to set the start of a memory dump offset or segment address to the index value (See Section ).

ICE-25 Set\_Mem\_Dump\_End\_Offset\_ICP/DAP/Segment-ICP/DAP -

The commands to set the end of a memory dump offset address to the index value (See Section ). A memory dump operation will not stop at this address so long as the packet data type is set to memory dump format. The packet address will continue incrementing and will rollover to the start of the memory register, if allowed to run long enough.

ICE-26 Set\_Azimuth/Elevation\_Encoder\_LED -

The commands to change the gimbal encoder LED intensity level. A high setting supposedly improves encoder readability under degraded LED operations.

ICE-27 Set\_Azimuth/Elevation\_Offset\_Correction -

The commands to change the internal gimbal position adjustment (offset) value to the corresponding index value. This value represents the difference between the actual gimbal position and the encoder indicated position. Changing this value allows for any corrections to encoder alignment that may be necessary.

ICE-28 Set\_Azimuth/Elevation\_Stall\_Error\_Thres -

The commands to change the default position error difference threshold used to determine stall conditions to the corresponding index value.

ICE-29 Set\_Azimuth/Elevation\_Stall\_Count\_Thres -

The commands to change the default number of samples where the gimbal position exceeds the stall error position threshold to the corresponding index value.

ICE-30 Set\_Packet\_Data\_Type -

The command to indicate which type of formatted science telemetry packets, indicated by the index value, to output. The APID will be set internally based on this packet format as shown in . The data packet format will actually change at the next packet boundary after receipt of this command.

ICE-31 Low\_Rate\_Science\_Transfer\_Enable (Terra Only) -

The command to transmit the science data to the spacecraft low rate data bus whenever this command is set to Enable (default). (The spacecraft providers have allowed instrumenters to transmit their science data on a higher rate data bus at their option, but CERES does not need to do this. The science and housekeeping data will be transmitted on separate low-rate buses.)

ICE-32 EOSAM\_Load\_Initiate (Terra Only) -

The command to clear the internal load data index for allowing the start of a new long command load sequence.

ICE-33 Set\_Scan\_Mode -

The command to change the elevation gimbal motion to the scan profile indicated by the index value. It will execute only on scan boundaries. When transmitted via spacecraft time-tagged stored command loads, it will be used as the primary solar avoidance mechanism during biaxial operations. During sunrise and sunset events, this command is to send the short-earth scan profile index. In between these events, the normal-earth scan profile index should be sent.

ICE-34 Command\_Cover\_Main -

The command to execute the cover operation specified by the index value. Opening and closing will cause the cover to move in a continuous operation. Care should be given when using this command in conjunction with the STEP\_MAIN\_COVER\_TO\_OPEN/CLOSE. See Reference for further details.

ICE-35 Command\_Cover\_MAM -

The command to execute the cover operation specified by the index value. Opening and closing will cause the cover to move in a continuous operation. Care should be given when using this command in conjunction with the STEP\_MAM\_COVER\_TO\_OPEN/CLOSE. See Reference for further details.

ICE-36 Set\_SWICS\_Intensity -

The command to either turn off the SWICS lamp or set the lamp’s intensity on to one of the three default settings specified by the index value.

ICE-37 Set\_Blackbody\_Temp\_Setpoint -

The command to set the desired blackbody heatsink temperature to a corresponding index value. Typically, this index value will be 1550, 2650, or 3550 that will correspond roughly to three calibration temperature values of 12, 32, and 52 degrees C., respectively. However, on-orbit ambient temperatures are typically greater than 12 degrees C. An alternative low index setpoint of 2100 (approximately 22 degrees C.) is being used. This command is primarily used for internal calibration operations.

ICE-38 Set\_Blackbody\_Temp\_Control -

The commands to turn the Total and Window channel blackbody heatsink temperature controllers on or off. The default is off. When on, the heaters will adjust the temperature based on the SET\_BLACKBODY\_TEMP\_SETPOINT command.

ICE-39 Set\_TOT/SW/WN\_Brid\_Bal\_Coarse\_DAC\_Val -

The commands to force the bridge balance circuitry coarse DAC value to the corresponding index value. Typically, this command is used for ground testing the dynamic response of the wheatstone bridge balancing operation.

ICE-40 Set\_TOT/SW/WN\_Brid\_Bal\_Fine\_DAC\_Val -

The commands to force the bridge balance circuitry fine DAC value to the corresponding index value. Typically, this command is used for ground testing the dynamic response of the wheatstone bridge balancing operation.

ICE-41 Set\_TOT/SW/WN\_Brid\_Bal\_Control\_Mode -

The commands to activate the bolometer sensor wheatstone bridge balance circuitry. The default is on.

ICE-42 Set\_TOT/SW/WN\_Sensor\_Temp\_Setpoint -

The commands to a desired bolomoter mounted heatsink temperature based on the corresponding index value. The nominal index value is set for 2048 counts which corresponds to approximately 38.0 degrees C.

ICE-43 Set\_TOT/SW/WN\_Sensor\_Temp\_Control -

The commands to turn the bolometer mounted heatsink temperature controllers on or off. The default is on.

ICE-44 Set\_TOT/SW/WN\_Sensor\_Temp\_Coef\_A0 -

The commands to change the A0 coefficient value that is used by the bolometer mounted heatsink, heater control algorithm. The value will be changed to the index value. (See Section for algorithm and default value details.)

ICE-45 Set\_TOT/SW/WN\_Sensor\_Temp\_Coef\_A1 -

The commands to change the A1 coefficient value that is used by the bolometer mounted heatsink, heater control algorithm. The value will be changed to the index value. (See Section for algorithm and default value details.)

ICE-46 Set\_TOT/SW/WN\_Sensor\_Temp\_Coef\_B1 -

The command to change the B1 coefficient value that is used by the bolometer mounted heatsink, heater control algorithm. The value will be changed to the index value. (See Section for algorithm and default value details.)

ICE-47 Set\_TOT/SW/WN\_Sensor\_Temp\_Coef\_D0 -

The command to change the D0 coefficient value that is used by the bolometer mounted heatsink, heater control algorithm. The value will be changed to the index value. (See Section for algorithm and default value details.)

ICE-48 Set\_Main\_Cover\_Active\_Pos\_Sensor -

The command to select which of the two position sensors will be used by the lag error evaluation logic for determining potentially skewed position operations.

ICE-49 Step\_Main\_Cover\_To\_Open -

The command to move the Main cover towards the open position in incremental steps, versus a normally continuous, full range slew to open. The size of the step is specified by the corresponding index value. While this command was originally meant to be used to recover from stuck motions (indicated via large lag errors), this command will be the normal method for on-orbit openings. Executing this command will disable the logic that would normally respond to lag error checks, even though the status parameter that monitors the lag will still indicate accumulated errors during motions.

ICE-50 Step\_MAM\_Cover\_To\_Open -

The command to move the MAM cover towards the open position in incremental steps, versus a normally continuous, full range slew to open. The size of the step is specified by the corresponding index value. This command is typically used as a means to recover from a high lag error due to a lack of cover travel.

ICE-51 Step\_Main\_Cover\_To\_Closed -

The command to move the Main cover towards the closed position in incremental steps, versus a normally continuous, full range slew to close. The size of the step is specified by the corresponding index value. While this command was typically meant to be used to recover from a lack of cover travel (indicated via large lag errors), this command will be the normal method for on-orbit closings. Executing this command will disable the logic that would normally respond to lag error checks, even though the status parameter that monitors the lag will still indicate accumulated errors during motions.

ICE-52 Step\_MAM\_Cover\_To\_Closed -

The command to move the MAM cover towards the closed position in incremental steps, versus a normally continuous, full range slew to close. The size of the step is specified by the corresponding index value. This command is typically used as a means to recover from a high lag error due to a lack of cover travel.

ICE-53 Set\_Main\_Cover\_Sensor\_1/2\_Lag\_Error -

The command to change the default accumulated lag error value used as a position difference threshold during cover motion operations. This threshold defines conditions that can indicate potential non-parallel alignment skewing between the two guide rails.

ICE-54 Set\_Submux\_Control (Aqua Only) -

The command to enable the output of the analog signal into the analog portion of the packet, the data associated with the specified Set\_Submux\_Fixed\_Channel command. This is helpful for anomaly investigations.

ICE-55 Set\_Submux\_Fixed\_Channel (Aqua Only) -

The command to output in the analog portion of the packet, the values that will be indicated by the selected multiplexing channel. Analog parameters and their corresponding submux channel are shown in .

ICE-56 Set\_Elevation\_Stow\_Pos -

The command to change the default angular position for the elevation gimbal stow position. This command is primarily used for ground calibration chamber test purposes and is not expected to be used during mission operations.

ICE-57 ICP/DAP\_Memory\_Load -

The long commands to perform RAM memory load updates. The format for the command ICP\_Memory\_Load is illustrated in and the command DAP\_Memory\_Load is shown in . The commands can be accepted in any instrument mode (as initiated via internal sequences).

ICE-58 ICP\_Sequence\_Table\_Load -

This long command to change any of the 16 internal sequence (macro) tables. The format for this command is illustrated in . This command can only be accepted when the instrument is in the Diagnostic Mode (as initiated via internal sequences).

ICE-59 ICP/DAP\_Unique\_Data\_Load-

The long commands to change specific data parameters typically related to mechanical operations controlled by the ICP (See )/DAP (See ). These commands can only be accepted when the instrument is in the Diagnostic Mode (as initiated via internal sequences).

ICE-60 DAP\_Scan\_Table\_Load -

This long command to change any of the 16 internal elevation gimbal scanning profile tables. The format for this command is illustrated in . This command can only be accepted when the instrument is in the Diagnostic Mode (as initiated via internal sequences).

Table ‑. DAP Long Command Formats

|  |  |  |
| --- | --- | --- |
| DAP Memory Load  Command Format | DAP Elevation Scan Table  Command Load Format | DAP Instrument Unique Data  Load Command Format |
| Memory Load Command | Scan Table Load Command | Instrument Unique Data Load  Command |
| Command I.D. No. | Command I.D. No. | Command I.D. No. |
| 32-bit Checksum (high byte) | 32-bit Checksum (high byte) | 32-bit Checksum (high byte) |
| 32-bit Checksum (low byte) | 32-bit Checksum (low byte) | 32-bit Checksum (low byte) |
| Memory Load Offset Address | Scan Table Entry | Elevation Offset Correction |
| Memory Load Segment Address | Number of Inflection Points | Main Cover Closed Position |
| Memory Load Length N | Inflection Point 0 Sample No. | Main Cover Open Position |
| Memory Load Value 0 | Inflection Point 0 Rate | Main Cover Closed Margin |
| Memory Load Value 1 | Inflection Point 0 Position | Main Cover Open Margin |
| Memory Load Value 2 | Inflection Point 1 Sample No. | MAM Cover Closed Position |
| Memory Load Value 3 | Inflection Point 1 Rate | MAM Cover Open Position |
| Memory Load Value 4 | Inflection Point 1 Position | MAM Cover Closed Margin |
| Memory Load Value 5 | --- | MAM Cover Open Margin |
| Memory Load Value 6 | Inflection Point 35 Sample No. |  |
| Memory Load Value 7 | Inflection Point 35 Rate |
| Memory Load Value 8 | Inflection Point 35 Position |
| Memory Load Value 9 | Bridge Bal. Begin Space Look |
| Memory Load Value 10 | Bridge Bal. End Space Look |
| --- | Bridge Bal. DAC Update |
| Memory Load Value N - 3 | Bridge Bal. Window High |
| Memory Load Value N - 2 | Bridge Bal. Window Low |
| Memory Load Value N - 1 | Bridge Bal. Window Setpoint |

| Table ‑. ICP Long Command Formats | | |
| --- | --- | --- |
| ICP Memory Load  Command Format | ICP Internal Sequence Load  Command Format | ICP Instrument Unique Data  Load Command Format |
| Memory Load  Command | Internal Sequence Load  Command | Instrument Unique Data Load  Command |
| Command I.D. No. | Command I.D. No. | Command I.D. No. |
| 32-bit Checksum (high byte) | 32-bit Checksum (high byte) | 32-bit Checksum (high byte) |
| 32-bit Checksum (low byte) | 32-bit Checksum (low byte) | 32-bit Checksum (low byte) |
| Memory Load Offset Address | Mode Index | Azimuth Offset Correction |
| Memory Load Segment Address | Mode Allowed Pattern | Brake Released Position |
| Memory Load Length N | Sample # & Sequence Control 0 | Brake Applied Position |
| Memory Load Value 0 | Scan Count 0 | Brake Caged Position |
| Memory Load Value 1 | Command 0 | Brake Released Margin |
| Memory Load Value 2 | Parameter 0 | Brake Applied Margin |
| Memory Load Value 3 | Sample # & Sequence Control 1 | Brake Caged Margin |
| Memory Load Value 4 | Scan Count 1 | Instrument I.D. No. |
| Memory Load Value 5 | Command 1 | Packet Data Version No. |
| Memory Load Value 6 | Parameter 1 |  |
| Memory Load Value 7 | --- |
| --- | Sample # & Sequence Control 27 |
| Memory Load Value N - 3 | Scan Count 27 |
| Memory Load Value N - 2 | Command 27 |
| Memory Load Value N - 1 | Parameter 27 |

| Table ‑. Allowable Sequence Mode Transition Table | | | | | | | | | | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| TO:  FROM: | **0 = Safe** | **1 = Standby** | **2 = Crosstrack** | **3 = Biaxial** | **4 = Solar Cal** | **5 = Diagnostic** | **6 = Int Calibration** | **7 = Special Short Scan** | **8 = Contamination Safe** | **9 = Hold** | **10 = Abbrev Int Cal** | **11 = Unused** | **12 = Unused** | **13 = Unused** | **14 = Unused** | **15 = Unused** |
| 0 = Safe | X | X |  |  |  | X |  |  |  |  |  |  |  |  |  |  |
| 1 = Standby | X | X | X | X | X |  | X | X | X | X | X | X | X | X | X | X |
| 2 = Crosstrack | X | X | X | X | X |  | X | X | X | X | X | X | X | X | X | X |
| 3 = Biaxial | X | X | X | X | X |  | X | X | X | X | X | X | X | X | X | X |
| 4 = Solar Cal | X | X | X | X | X |  | X | X | X | X | X | X | X | X | X | X |
| 5 = Diagnostic | X |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 6 = Int Calibration | X | X | X | X | X |  | X | X | X | X | X | X | X | X | X | X |
| 7 = Special Short Scan | X | X | X | X | X |  | X | X | X | X | X | X | X | X | X | X |
| 8 = Contamination Safe | X | X |  |  |  |  |  |  | X |  |  |  |  |  |  |  |
| 9 = Hold | X | X | X | X | X |  | X | X | X | X | X | X | X | X | X | X |
| 10 = Abbrev Int Cal | X | X | X | X | X |  | X | X | X | X | X | X | X | X | X | X |
| 11 = Unused | X | X | X | X | X |  | X | X | X | X | X | X | X | X | X | X |
| 12 = Unused | X | X | X | X | X |  | X | X | X | X | X | X | X | X | X | X |
| 13 = Unused | X | X | X | X | X |  | X | X | X | X | X | X | X | X | X | X |
| 14 = Unused | X | X | X | X | X |  | X | X | X | X | X | X | X | X | X | X |
| 15 = Unused | X | X | X | X | X |  | X | X | X | X | X | X | X | X | X | X |

| Table ‑. Instrument Commands Allowed by Mode | | | | | |
| --- | --- | --- | --- | --- | --- |
| Command Description | All Modes | All Modes  (except  Safe) | All Modes  (except  Safe &  Diagnostic) | Safe or  Diagnostic  Modes Only | Diagnostic  Mode  Only | |
| No\_Command\_ICP | X |  |  |  |  | |
| Command\_Azimuth\_Goto\_Position |  | X |  |  |  | |
| Set\_Azimuth\_Fixed\_Crosstrack |  | X |  |  |  | |
| Set\_Azimuth\_Fixed\_Position\_A |  | X |  |  |  | |
| Set\_Azimuth\_Fixed\_Position\_B |  | X |  |  |  | |
| Set\_Azimuth\_Fixed\_SolarCal |  | X |  |  |  | |
| Set\_Azimuth\_Fixed\_Caged |  | X |  |  |  | |
| Set\_Azimuth\_Fixed\_Spare\_1 |  | X |  |  |  | |
| Set\_Azimuth\_Fixed\_Contam\_Pos |  | X |  |  |  | |
| Set\_Azimuth\_Fixed\_Spare\_3 |  | X |  |  |  | |
| Set\_Azimuth\_Rate\_Goto\_Rate |  |  |  |  | X | |
| Set\_Azimuth\_Rate\_Async\_Rate |  |  |  |  | X | |
| Set\_Azimuth\_Rate\_Sync\_Rate |  |  |  |  | X | |
| Command\_Brake |  | X |  |  |  | |
| Step\_Brake\_To\_Caged |  | X |  |  |  | |
| Step\_Brake\_To\_Applied |  | X |  |  |  | |
| Set\_Instrument\_Mode  (per Allowable Sequence Transition Table) | X |  |  |  |  | |
| Set\_Safehold\_Response\_A  (TRMM Command) |  |  |  | X |  | |
| Set\_Safehold\_Response\_B  (TRMM Command) |  |  |  | X |  | |
| Set\_SPS1\_Response |  |  |  |  | X | |
| Set\_SPS2\_Response |  |  |  |  | X | |
| Set\_SPS1\_Threshold\_Noise |  |  |  |  | X | |
| Set\_SPS2\_Threshold\_Noise |  |  |  |  | X | |
| Set\_SPS1\_Threshold\_Numerator |  |  |  |  | X | |
| Set\_SPS2\_Threshold\_Numerator |  |  |  |  | X | |
| Set\_SPS1\_Threshold\_Count |  |  |  |  | X | |
| Set\_SPS2\_Threshold\_Count |  |  |  |  | X | |
| Set\_Scan\_Timeout\_Response |  |  |  |  | X | |
| Set\_Scan\_Timeout\_Count |  | X |  |  |  | |
| Set\_Quicklook\_Flag | X |  |  |  |  | |
| Select\_Time\_Mark\_Frequency\_Bus  (Terra/Aqua/S-NPP Command) | X |  |  |  |  | |
| Set\_Time\_Mark\_Frequency\_Response  (Terra/Aqua/S-NPP Command) | X |  |  |  |  | |
| Set\_IMOK\_Signal\_Response  (Terra/S-NPP Command) |  |  |  | X |  | |
| Set\_Watchdog\_Timer\_ICP |  |  |  |  | X | |
| Set\_PROM\_Power\_ICP |  |  |  |  | X | |
| Set\_Mem\_Dump\_Start\_Offset\_ICP |  | X |  |  |  | |
| Set\_Mem\_Dump\_Start\_Segment\_ICP |  | X |  |  |  | |
| Set\_Mem\_Dump\_End\_Offset\_ICP |  | X |  |  |  | |
| Set\_Mem\_Dump\_End\_Segment\_ICP |  | X |  |  |  | |
| Set\_Azimuth\_Encoder\_LED |  |  |  |  | X | |
| Set\_Azimuth\_Offset\_Correction |  |  |  |  | X | |
| Set\_Azimuth\_Stall\_Error\_Thres |  |  |  |  | X | |
| Set\_Azimuth\_Stall\_Count\_Thres |  |  |  |  | X | |
| Set\_Packet\_Data\_Type | X |  |  |  |  | |
| Low\_Rate\_Science\_Transfer\_Enable  (Terra Command) | X |  |  |  |  | |
| EOSAM\_Load\_Initiate  (Terra Command) |  |  |  | X |  | |
| No\_Command\_DAP | X |  |  |  |  | |
| Set\_Scan\_Mode |  | X |  |  |  | |
| Command\_Cover\_Main |  |  |  |  | X | |
| Command\_Cover\_MAM |  |  |  |  | X | |
| Set\_SWICS\_Intensity |  | X |  |  |  | |
| Set\_Blackbody\_Temp\_Setpoint |  | X |  |  |  | |
| Set\_Blackbody\_Temp\_Control |  | X |  |  |  | |
| Set\_Tot\_Brid\_Bal\_Coarse\_DAC\_Val |  |  |  |  | X | |
| Set\_SW\_Brid\_Bal\_Coarse\_DAC\_Val |  |  |  |  | X | |
| Set\_WN\_Brid\_Bal\_Coarse\_DAC\_Val |  |  |  |  | X | |
| Set\_Tot\_Brid\_Bal\_Fine\_DAC\_Val |  |  |  |  | X | |
| Set\_SW\_Brid\_Bal\_Fine\_DAC\_Val |  |  |  |  | X | |
| Set\_WN\_Brid\_Bal\_Fine\_DAC\_Val |  |  |  |  | X | |
| Set\_Tot\_Brid\_Bal\_Control\_Mode |  |  |  |  | X | |
| Set\_SW\_Brid\_Bal\_Control\_Mode |  |  |  |  | X | |
| Set\_WN\_Brid\_Bal\_Control\_Mode |  |  |  |  | X | |
| Set\_Tot\_Sensor\_Temp\_Setpoint |  |  |  |  | X | |
| Set\_SW\_Sensor\_Temp\_Setpoint |  |  |  |  | X | |
| Set\_WN\_Sensor\_Temp\_Setpoint |  |  |  |  | X | |
| Set\_Tot\_Sensor\_Temp\_Control |  |  |  |  | X | |
| Set\_SW\_Sensor\_Temp\_Control |  |  |  |  | X | |
| Set\_WN\_Sensor\_Temp\_Control |  |  |  |  | X | |
| Set\_Tot\_Sensor\_Temp\_Coef\_A0 |  |  |  |  | X | |
| Set\_SW\_Sensor\_Temp\_Coef\_A0 |  |  |  |  | X | |
| Set\_WN\_Sensor\_Temp\_Coef\_A0 |  |  |  |  | X | |
| Set\_Tot\_Sensor\_Temp\_Coef\_A1 |  |  |  |  | X | |
| Set\_SW\_Sensor\_Temp\_Coef\_A1 |  |  |  |  | X | |
| Set\_WN\_Sensor\_Temp\_Coef\_A1 |  |  |  |  | X | |
| Set\_Tot\_Sensor\_Temp\_Coef\_B1 |  |  |  |  | X | |
| Set\_SW\_Sensor\_Temp\_Coef\_B1 |  |  |  |  | X | |
| Set\_WN\_Sensor\_Temp\_Coef\_B1 |  |  |  |  | X | |
| Set\_Tot\_Sensor\_Temp\_Coef\_D0 |  |  |  |  | X | |
| Set\_SW\_Sensor\_Temp\_Coef\_D0 |  |  |  |  | X | |
| Set\_WN\_Sensor\_Temp\_Coef\_D0 |  |  |  |  | X | |
| Set\_Main\_Cover\_Active\_Pos\_Sensor |  |  |  |  | X | |
| Step\_Main\_Cover\_To\_Open |  |  |  |  | X | |
| Step\_MAM\_Cover\_To\_Open |  |  |  |  | X | |
| Step\_Main\_Cover\_To\_Closed |  |  |  |  | X | |
| Step\_MAM\_Cover\_To\_Closed |  |  |  |  | X | |
| Set\_Main\_Cover\_Sensor\_1\_Lag\_Error |  |  |  |  | X | |
| Set\_Main\_Cover\_Sensor\_2\_Lag\_Error |  |  |  |  | X | |
| Set\_Submux\_Control |  |  |  |  | X | |
| Set\_Submux\_Fixed\_Channel |  |  |  |  | X | |
| Set\_Elevation\_Stow\_Pos |  |  |  |  | X | |
| Set\_Watchdog\_Timer\_DAP |  |  |  |  | X | |
| Set\_PROM\_Power\_DAP |  |  |  |  | X | |
| Set\_Mem\_Dump\_Start\_Offset\_DAP |  | X |  |  |  | |
| Set\_Mem\_Dump\_Start\_Segment\_DAP |  | X |  |  |  | |
| Set\_Mem\_Dump\_End\_Offset\_DAP |  | X |  |  |  | |
| Set\_Mem\_Dump\_End\_Segment\_DAP |  | X |  |  |  | |
| Set\_Elevation\_Encoder\_LED |  |  |  |  | X | |
| Set\_Elevation\_Offset\_Correction |  |  |  |  | X | |
| Set\_Elevation\_Stall\_Error\_Thres |  |  |  |  | X | |
| Set\_Elevation\_Stall\_Count\_Thres |  |  |  |  | X | |
| ICP\_Memory\_Load | X |  |  |  |  | |
| ICP\_Sequence\_Table\_Load |  |  |  |  | X | |
| ICP\_Unique\_Data\_Load |  |  |  |  | X | |
| DAP\_Memory\_Load | X |  |  |  |  | |
| DAP\_Unique\_Data\_Load |  |  |  |  | X | |

Analog Parameter Submultiplexer Channels

| Table ‑. Analog Parameter Submultiplexer Channels | | | |
| --- | --- | --- | --- |
| DAA Analog Parameters | Submux  Channel | ICP Analog Parameters | Submux  Channel |
| SPS\_1\_NARROW\_FOV\_OUTPUT | 196 | AZIMUTH\_BRAKE\_POSITION | 163 |
| SPS\_1\_WIDE\_FOV\_OUTPUT | 197 | AZIMUTH\_LOWER\_BEARING\_TEMP | 106 |
| SPS\_2\_NARROW\_FOV\_OUTPUT | 198 | ACA\_ELECTRONICS\_TEMP | 104 |
| SPS\_2\_WIDE\_FOV\_OUTPUT | 199 | ACA\_TORQUE\_OUTPUT | 162 |
| MAIN\_COVER\_POSITION\_1 | 166 | ACA\_ENCODER\_CLEAR\_TRACK\_A | 164 |
| MAIN\_COVER\_POSITION\_2 | 167 | ACA\_ENCODER\_CLEAR\_TRACK\_B | 165 |
| MAM\_COVER\_POSITION | 163 | ECA\_TORQUE\_OUTPUT | 0 |
| MAIN\_COVER\_MOTOR\_TEMP | 107 | ECA\_ENCODER\_CLEAR\_TRK\_CORSE | 32 |
| TOT\_DETECTOR\_CONTROL\_TEMP | 32 | ECA\_ENCODER\_CLEAR\_TRK\_FINE | 64 |
| TOT\_DETECTOR\_MONITOR\_TEMP | 0 | ICA\_PROM\_ELECTRONICS\_TEMP | 109 |
| SW\_DETECTOR\_CONTROL\_TEMP | 34 | ICA\_ADC\_ELECTRONICS\_TEMP | 111 |
| SW\_DETECTOR\_MONITOR\_TEMP | 2 | PCA\_ELECTRONICS\_TEMP | 98 |
| WN\_DETECTOR\_CONTROL\_TEMP | 33 | ICA\_SPARE\_CHANNEL\_1 | 96 |
| WN\_DETECTOR\_MONITOR\_TEMP | 1 | PEDESTAL\_TEMP\_ICA\_RADIATOR | 97 |
| SENSOR\_ELECTRONICS\_TEMP | 121 | PEDESTAL\_TEMP\_1\_RADIATOR | 99 |
| SENSOR\_MODULE\_TEMP | 120 | PEDESTAL\_TEMP\_2\_ISOLATOR | 100 |
| ELEVATION\_SPINDLE\_TEMP\_MOTOR | 123 | ICA\_SPARE\_CHANNEL\_2 | 102 |
| ELEVATION\_SPINDLE\_TEMP\_CW | 122 | ICA\_SPARE\_CHANNEL\_3 | 103 |
| ELEVATION\_BEARING\_TEMP\_CW | 102 | PEDESTAL\_TEMP\_PCA\_RADIATOR | 105 |
| ELEVATION\_BEARING\_TEMP\_MOTOR | 106 | ICA\_PLUS\_5V\_DIGITAL | 130 |
| ECA\_ELECTRONICS\_TEMP | 104 | ICA\_PLUS\_15V\_TO\_ECA\_ACA | 132 |
| ECA\_RADIATOR\_TEMP | 105 | ICA\_MINUS\_15V\_TO\_ECA\_ACA | 133 |
| SPARE\_CHANNEL\_1 | 64 | ICA\_PLUS\_5V\_TO\_DAA | 128 |
| SPARE\_CHANNEL\_2 | 65 | ICA\_PLUS\_10V\_TO\_DAA | 129 |
| SPARE\_CHANNEL\_3 | 66 | ICA\_PLUS\_15V\_INTERNAL | 134 |
| SPARE\_CHANNEL\_4 | 67 | ICA\_MINUS\_15V\_INTERNAL | 135 |
| TOT\_BLACKBODY\_TEMP | 224 | RESERVED\_FOR\_DAA\_DATA | 253 |
| WN\_BLACKBODY\_TEMP | 225 | RESERVED\_FOR\_DAA\_DATA | 254 |
| SWICS\_PHOTODIODE\_TEMP | 103 | ICA\_SPARE | 255 |
| SWICS\_PHOTODIODE\_OUTPUT | 226 |  |  |
| SWICS\_LAMP\_CURRENT | 227 |  |  |
| MAM\_TOT\_BAFFLE\_TEMP\_1 | 96 |  |  |
| MAM\_TOT\_BAFFLE\_TEMP\_2 | 97 |  |  |
| AZIMUTH\_UPPER\_BEARING\_TEMP | 98 |  |  |
| SPARE\_CHANNEL\_5 | 99 |  |  |
| MAM\_ASSEMBLY\_SW\_TEMP | 100 |  |  |
| MAM\_ASSEMBLY\_TOT\_TEMP | 101 |  |  |
| DAA\_CPU\_ELECTRONICS\_TEMP | 108 |  |  |
| DAA\_ADC\_ELECTRONICS\_TEMP | 111 |  |  |
| DAA\_RADIATOR\_TEMP | 112 |  |  |
| DETECTOR\_POSITIVE\_120V\_BIAS | 228 |  |  |
| DETECTOR\_NEGATIVE\_120V\_BIAS | 229 |  |  |
| DAA\_PLUS\_5V\_DIGITAL | 128 |  |  |
| DAA\_PLUS\_10V\_REFERENCE | 129 |  |  |
| SPARE\_CHANNEL\_6 | 130 |  |  |
| DAA\_MINUS\_10V\_REFERENCE | 131 |  |  |
| SEA\_PLUS\_15V\_ANALOG | 132 |  |  |
| SEA\_MINUS\_15V\_ANALOG | 133 |  |  |
| DAA\_PLUS\_15V\_ANALOG | 134 |  |  |
| DAA\_MINUS\_15V\_ANALOG | 135 |  |  |
| DAA\_PLUS\_130V | 160 |  |  |
| DAA\_MINUS\_130V | 161 |  |  |
| DAA\_ANALOG\_GROUND\_REF\_1 | 230 |  |  |
| DAA\_ANALOG\_GROUND\_REF\_2 | 231 |  |  |
| TOT\_CHAN\_HEATER\_DAC\_VALUE | 250 |  |  |
| SW\_CHAN\_HEATER\_DAC\_VALUE | 251 |  |  |
| WN\_CHAN\_HEATER\_DAC\_VALUE | 252 |  |  |
| BLACKBODY\_HEATER\_DAC\_VALUE | 253 |  |  |
| RESERVED\_FOR\_USE\_BY\_THE\_ICA | 254 |  |  |
| DAA\_SPARE | 255 |  |  |

Flight Code Memory Description

The on-board instrument memory for each processor contains 64 Kbytes, consisting of Read Only Memory (ROM) and Random Access Memory (RAM). The mapping of this memory space, with the corresponding offset and segment addresses is shown in . Upon every power-up, commanded reset, or watchdog time-out reset, a copy of the ROM software is loaded into the RAM space. Then, additional memory patches (to correct deficiencies) need to be loaded. The following tables through show a list of these patches and are uploaded according to flight operational procedures.



Figure ‑. ICP and DAP Memory Maps (Aqua FM 4 Example)

Table ‑. PFM (TRMM) Memory Patch Loads

|  |  |  |
| --- | --- | --- |
| Item # | Patch Reference | Patch Description |
| 1 | HK Command Fix | Fix the HK command error to be the most recent rather than the oldest. |
| 2 | Time Mark | Fixes an ICP spacecraft Time Mark Halt collision handler. |
| 3 | DAP Clock Interrupt | Fixes a DAP 100Hz timing interrupt service routine. |
| 4 | ICP Clock Interrupt | Fixes a ICP 100Hz timing interrupt service routine. |

Table ‑. FM 1 (Terra) Memory Patch Loads

|  |  |  |
| --- | --- | --- |
| Item # | Patch Reference | Patch Description |
| 1 | Time Mark | Fixes an ICP spacecraft Time Mark Halt collision handler. |
| 2 | Brake Margin | Updates the azimuth brake defined At\_Apply position from 685 to 687 and its margin from 5 to 12 counts. |
| 3 | 1553 Service | Fixes the 1553B Service Request Bit to allow spacecraft  communications to continue. |
| 4 | 1553 Stack Error | Modifies the flight software to call the new 1553B stack  management function and call an ERROR-50 if detection occurs. |
| 5 | MAM Scan | Replaces an erroneous MAM scan profile with the original MAM scan profile to match the FM 2 profile. |
| 6 | WN Bridge Balance | Change WN channel bridge balance setpoints. |
| 7 | Quicklook Flag | Enable instrument to respond to quicklook flag command |
| 8 | Lunar Scan | Add 3 elevation position stare profiles for lunar calibrations. |
| 9 | Azimuth Sync | Change Azimuth A/B sync operations to A-only sync. |
| 10 | Internal Cal | Raised the blackbody setpoints. |
| 11 | SW Internal Cal | Load a long SWICS period alternative internal calibration mode. |
| 12 | Nadir Profile | Load double nadir elevation profile |
| 13 | MAM Dwell | Change MAM elevation profile to MAM stare. |

Table ‑. FM 2 (Terra) Memory Patch Loads

|  |  |  |
| --- | --- | --- |
| Item # | Patch Reference | Patch Description |
| 1 | Time Mark | Fixes an ICP spacecraft Time Mark Halt collision handler. |
| 2 | Brake Margin | Updates the azimuth brake defined At\_Cage margin from 5 to 7 counts. |
| 3 | 1553 Stack Error | Modifies the flight software to call the new 1553B stack  management function and call an ERROR-50 if detection occurs. |
| 4 | WN Bridge Balance | Change WN channel bridge balance setpoints. |
| 5 | Quicklook Flag | Enable instrument to respond to quicklook flag command |
| 6 | Lunar Scan | Add 3 elevation position stare profiles for lunar calibrations. |
| 7 | Azimuth Sync | Change Azimuth A/B sync operations to A-only sync. |
| 8 | Internal Cal | Raised the blackbody setpoints. |
| 9 | SW Internal Cal | Load a long SWICS period alternative internal calibration mode. |
| 10 | Nadir Profile | Load double nadir elevation profile |
| 11 | MAM Dwell | Change MAM elevation profile to MAM stare. |
| 12 | SubMux Table | Copy TOT channel monitor temperature into control temperature slot. |
| 14 | Heater Control | Total channel temperature control law function replaced when temperature control thermistor failed. |

Table ‑. FM 3 (Aqua) Memory Patch Loads

|  |  |  |
| --- | --- | --- |
| Item # | Patch Reference | Patch Description |
| 1 | TimeStamp Rollover | Fixed microsecond to millisecond rollover condition. |
| 2 | Azimuth Rate Limit | Change rate limit threshold to 0.5…30 degree/second |
| 3 | Azimuth Slew | Change default scanning rate to 4 degree/second |
| 4 | WN Bridge Balance | Change WN channel bridge balance setpoints. |
| 5 | Quicklook Flag | Enable instrument to respond to quicklook flag command |
| 6 | Lunar Scan | Add 3 elevation position stare profiles for lunar calibrations. |
| 7 | Azimuth Sync | Change Azimuth A/B sync operations to A-only sync. |
| 8 | Nadir Profile | Load double nadir elevation profile |
| 9 | MAM Dwell | Change MAM elevation profile to MAM stare. |
| 10 | SW Internal Cal | Load a long SWICS period alternative internal calibration mode. |
| 11 | Internal Cal | Raised the blackbody setpoints. |

Table ‑. FM 4 (Aqua) Memory Patch Loads

|  |  |  |
| --- | --- | --- |
| Item # | Patch Reference | Patch Description |
| 1 | TimeStamp Rollover | Fixed microsecond to millisecond rollover condition. |
| 2 | Azimuth Rate Limit | Change rate limit threshold to 0.5…30 degree/second |
| 3 | Azimuth Slew | Change default scanning rate to 4 degree/second |
| 4 | WN Bridge Balance | Change WN channel bridge balance setpoints. |
| 5 | SW Heater Control | Disable the SW heater control temperature in the control law. |
| 6 | Quicklook Flag | Enable instrument to respond to quicklook flag command |
| 7 | Lunar Scan | Add 3 elevation position stare profiles for lunar calibrations. |
| 8 | Azimuth Sync | Change Azimuth A/B sync operations to A-only sync. |
| 9 | Nadir Profile | Load double nadir elevation profile |
| 10 | MAM Dwell | Change MAM elevation profile to MAM stare. |
| 11 | SW Internal Cal | Load a long SWICS period alternative internal calibration mode. |
| 12 | Internal Cal | Raised the blackbody setpoints. |

1. FM 5 (S-NPP) Memory Patch Loads

|  |  |  |
| --- | --- | --- |
| Item # | Patch Reference | Patch Description |
| 1 | ICP TimeStamp | Fixed timestamp at load error. |
| 2 | MAM Dwell | Change MAM elevation profile to MAM stare. |
| 3 | Bridge Balance | Change WN channel bridge balance setpoints. |
| 4 | Azimuth Sync | Change Azimuth A/B sync operations to A-only sync. |
| 5 | SPS Response | Allow SPS enabling in an instrument mode. |

Flight Code Heater Algorithm

The control of the detector channel heatsinks and the blackbody temperatures are governed by the following algorithms, as described in TRW DRL-87 (See Reference ). Note, the heater control algorithm default coefficient values are the same for all instruments.

where:

and :

for *t* = current sample value, *t*-1 = previous sample value.

Table ‑. Heater Control Algorithm Default Coefficient Values

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Heater | A0 | A1 | B1 | C0 | C1 | C2 | D0 |
| Sensors | 29761 | -29266 | -16367 | 991 | 100 | 119 | 54 |
| Blackbody | 17468 | 0 | 0 | 0 | 15000 | 1414 | 0 |

Programmer Notes

Solar Avoidance System

The CERES instrument Sun-avoidance system has three levels:

1. Scheduled spacecraft transmitted Set\_Scan\_Mode solar avoidance command. This command involves placing the elevation scanner into the short-earth scan profile in a planned timely manner based on mission operations planning aids. These planning aids identify the anticipated Sun terminator regions (sunrise and sunset events). The short-earth scan profile will be commanded prior to entering a terminator region and the normal-earth scan profile will be commanded after leaving a terminator region. Generally, an approximately two minute buffer margin is used about these events.
2. In the event the Set\_Scan\_Mode solar avoidance command is not received from the spacecraft, for whatever reason, a second-tier solar avoidance is activated. This condition involves using the a Set\_Scan\_Timeout\_Count command used to preset an internal scan time-out counter that will place the elevation scanner into the short-earth scan profile. Normally, this command is a scheduled command that is along with the Set\_Scan\_Mode.

This counter is activated whenever the following conditions are true:

1. The azimuth scan mode is one of the A-B scanning operations, AND,
2. The elevation scan mode is in the normal-earth scan profile, AND,
3. The scan time-out response has been enabled.

Once these conditions are satisfied, an internal counter begins counting down from the preset value specified by the Set\_Scan\_Timeout\_Count command. The value of this command count is calculated to ensure that the count (time-out) should occur approximately one minute after the Set\_Scan\_Mode command should have issued a short-earth scan directive. Then after each sun terminator event, a new value is loaded at the same time as the Set\_Scan\_Mode to normal-earth scan directive is issued, thereby repeating the cycle. If no further spacecraft issued commands are received, the instrument will remain in a short-earth scan profile until commanded otherwise. CAUTION: Along-track operations can orient the instrument to cause the bolometer sensors to scan the Sun. However, because the instrument is not performing an azimuth scan operation, this solar avoidance tier is not active. Therefore, extreme caution is to be exercised by operators.

1. Safing via sun presence sensor (SPS) issued solar warning detection. This third tier solar avoidance operation involves using the SPSs to detect when movement of the instrument and the Sun will cause the bolometer sensor FOV to align with the Sun line-of-sight. These SPSs have a nominal optical FOV of ±5 degrees in the azimuth plane and ±15 degrees in the elevation plane. However, they are able to detect the Sun over a ±8 degrees in the azimuth plane and ±22 degrees in the elevation plane. The optical line-of-sight centerline is -13 degrees in the Instrument coordinate system for the PFM instrument and -18 degrees for the FM 1-5 instruments. See . (A 5 degree shim as mounted under the SPS module for the latter instruments.) Thus, TRMM mission experience has shown that the Sun can be seen by the SPSs in the elevation plane from -23 to +5 degrees. When the SPSs have detected the Sun, per DRL-64, - Solar Presence Sensor (SPS):, a solar warning signal is given that causes the instrument to execute the Safe sequence. The instrument can then only be returned to science configurations via real-time spacecraft contact.

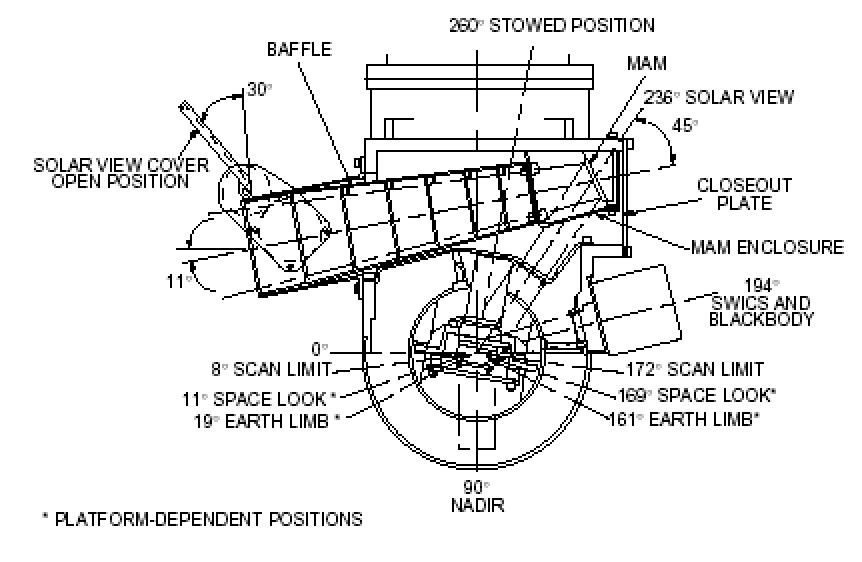


Figure ‑. Elevation Scan Angles

**Algorithm 6** - Solar Presence Sensor (SPS):

The detection and presence of the Sun by the SPS is derived based on the following algorithm that is executed 60 times per scan (every 0.11 seconds), using SPS1 as the example. This algorithm is condensed from text in DRL-87 (Reference ) and is based on flowcharts shown in DRL-64 (Reference ).

1. If (SPS1\_Wide\_FOVl >= SPS1\_Threshold\_Noise) AND

(SPS1\_Narrow\_FOV >= (SPS1\_Wide\_FOV/2))

then Detection State = Sun\_Detected (for this sample)

1. If Detection\_State = Sun\_Detected AND

(0 > Solar\_Detection\_Count < Solar\_Detection\_Count\_Threshold)

then Increment Solar\_Detection\_Count

else Decrement Solar\_Detection\_Count

1. If Solar\_Detection\_Count >= Solar\_Detection\_Count\_Threshold

then Detection State = Sun\_Present (at this sample)

1. If Detection State = Sun\_Present AND

SPS1\_Response = Enabled AND

Elevation\_Scan\_Mode = Normal\_Earth\_Scan

then A Solar Warning will be issued to safe the instrument:

Note: The Safing internal sequence command itself will not appear on the command stack.

Sensor Spurious Slow Mode Algorithm

A mathematical derivation of how this spurious slow mode compensation algorithm works can be explained in three parts: (1) the generation of an analog signal containing the original radiance measurement influenced by the spurious slow mode effect, (2) the digital representation of this measurement, and (3) processing the digitized measurement to deconvolve the spurious effects. Note that for theoretical clarity, gain (radiance to count ratio) will not be included in this discussion.

u(t)

v(t)

w(t)

w(k)

Sample

Signal

Formation

Spurious

Modes

Radiance

Input

r(t)

Figure ‑. Radiometer and Electronics Block Diagram

**A. Analog Representation:**

Using above, the desired analog signal that needs to be converted to filtered radiances is the undistorted signal. However this signal is being corrupted by a superimposed spurious signal resulting in an "over-estimated" sensor measurement , where . There is a fundamental assumption that the spurious signal is much slower then the fast undistorted signal and can thus be approximated as a proportional signal of *.* Further, to simplify the mathematics and relate the sensor system operation, a unit-step response function is utilized through out. We begin by assuming that could be derived for a known using the following equation:

(1)

where:

λ = Slow Mode characteristic time constant 1/ζ

c = modal amplitude factor

Solving this equation analytically using a unit-step input for and t→∞, then could be reduced to following:

(2)

Thus, the "overestimated" radiance measurement signal seen prior to sampling becomes:

(3)

However, since is not known, an approximation of is needed which can be expressed in terms of the known measurement in addition to an assumption about the "over-estimating" spurious effect influence. This assumption takes the form of an simplified single mode approximation equation:

(4) as t→∞

Solving this equation with an asymptotically unit-step function yields the following results:

By rewriting the equation (4) assumption to be: and plugging this into equation (1), this equation (1) now takes the form of the following:

(5) or

(6)

Solving this integral using the same unit step input results in the following sequence of steps:

(7)

Cancelling common terms reduces this to the following:

(8)

**B. Digital Representation:**

This algorithm now needs to go one step further and account for the sampling effects of the analog measurement . The resultant discrete signal can be analyzed using digital signal processing (DSP) techniques. Thus, the convolution required by equation (7) can be represented by first defining a DSP summation/convolution equation with the following form:

(9)

Where ∆*t* corresponds to the CERES sampling interval, hence the time of the sample is .

To expand this summation, the following approximations are assumed (e.g. time domain):

for

for

which leads to the following conditions: and . The expansion of equation (9) is therefore:

(10)

By setting to zero for all *j* less than or equal to zero and plugging in the above conditions, then equation (10) becomes:

(11)

This is representative of a geometric summation formula with *k* terms. The common form of this equation is expressed as:

(12) which can be reduced to:

(13)

This expression can be used to provide us with the following simplistic, relevant coefficients from equation (11): and . Substituting these coefficients back into this last equation (13) yields:

(14)

Remembering that and by rearranging equation (8) to be: , then equation (14) can be rewritten as:

(15)

Rearranging yields:

(16) and using substitutions then yields:

(17)

This allows us to now establish the following filter weighting coefficients:

(18) and ,

which reduces equation (17) to the following:

(19)

**C. Deconvolution:**

While this last equation, and the constants that define the slow mode characteristics, give an estimate of the slow mode response on a raw DSP output , the real-time calculations to compute the corrected detector signal from are inefficient to perform. Instead, we can predict the value of using the raw signal and the previous estimated slow mode signal . The previous signal equation is:

(20)

Expanding these last two summation equations, yields:

(21)

(22)

Combining them (substituting into equation 21) then yields:

(23)

For recursion to work with this last equation though, the previous sample must be known. If it isn’t, then the start of the iteration process uses the assumption that the second time constant effects has settled out. Mathematically this can be represented as:

(24)

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