
AQUARIUS/SAC-D

AQUARIUS LEVEL-1A DATA PRODUCT

Aquarius Project Document: **AQ-014-PS-0007**
July 29, 2014

Version 3.0



Aquarius Level-1A Data Product

PREPARED BY (CUSTODIAN):

Frederick S. Patt

Date

APPROVED BY:

Gene Carl Feldman

Date

DOCUMENT CHANGE LOG

Change Number	Change Date	Pages Affected	Changes/ Notes	General Comments
-	22 February 2013	All	V2.0 Release	
1	20 December 2013	Tables 1-17	Added index column to telemetry tables per Piepmeier request.	
2	29 July 2014	7, 9	Added explanation of frame and subframe indexing of radiometer raw data objects.	

1.0 Introduction

This document describes the specifications of the Aquarius Level-1A archive products that are produced and distributed by the NASA Goddard Space Flight Center (GSFC) Aquarius Data Processing System (ADPS). The products are implemented in the Hierarchical Data Format 5 (HDF5), and HDF terminology is used in this document.

These specifications are given in terms of the logical implementation of the products in HDF and are not a physical description of file contents. Therefore, HDF software must be used to create or read these products.

An Aquarius Level-1A product is generated from one or more Level-0 data files. It contains all the Level-0 data (raw sample counts from the radiometer and scatterometer as well as spacecraft and instrument telemetry), appended navigation data, and (optionally) selected instrument and spacecraft telemetry that are reformatted and also appended. This product is stored as one physical HDF file.

Each product contains data from one orbit of Aquarius data, plus additional data before and after the orbit to provide buffering for downstream data processing. An orbit is defined as starting when the SAC-D spacecraft passes the South Pole. An orbit may be downlinked multiple times (either to the CONAE ground station at Cordoba or the Matera ground station operated by ASI). The best quality data will be selected for each orbit during the Level 0-to-1A and the L1A-merge data processing and used to create the final Level 1A file.

This is the first draft of this document, and is based on the understanding of the current Aquarius instrument documentation. All information herein is open to revision.

2.0 Naming Convention

The form of a Level-1A file name is Qyyydddhhmss.L1A_ttt, where Q is for Aquarius, yyydddhhmss are the concatenated digits for the UTC year, day of the year, hours, minutes, and seconds of the first sample (block) in the product, and ttt is the type of data in the product. Examples of file names are:

Q2011286112700.L1A_SCI for normal science data

3.0 Global Attributes

For global attributes that have constant values specific to this product type, the value is given.

3.1 Mission and Documentation

Product Name (character): the name of the product file (without path).

Title (character): "Aquarius Level-1A Data".

Data Center (character): "NASA/GSFC Aquarius Data Processing Center".

Mission (character): "SAC-D Aquarius".

Mission Characteristics (character): "Nominal orbit: inclination = 98.0 (Sun-synchronous); node = 6 PM (ascending); eccentricity = <0.002; altitude = 657 km; ground speed = 6.825 km/sec".

Sensor (character): "Aquarius".

Data Type (character): "SCI".

Software ID (character): identifies version of the operational software used to create this product.

Processing Time (character): local time of generation of this product; concatenated digits for year, day-of-year, hours, minutes, seconds, and fraction of seconds in the format of YYYYDDDHHMMSSFFF.

Input Files (character): the name of the temporary Level-1A file(s) (without path) from which the current product was created.

Processing Control (character): all input and processing control parameters used by the calling program to generate the product. Vertical bars or carriage return characters serve as parameter information delimiters.

3.2 Data Time

Start Time (character): start UTC of the first block of the product, including additional data for downstream processing; concatenated digits for year, day-of-year, hours, minutes, seconds, and fraction of seconds in the format of YYYYDDDHHMMSSFFF.

End Time (character): start UTC of the last block of the product, including additional data for downstream processing; concatenated digits for year, day-of-year, hours, minutes, seconds, and fraction of seconds in the format of YYYYDDDHHMMSSFFF.

Orbit Start Time (character): UTC of the start of the orbit included in the product, defined as the South pole crossing; concatenated digits for year, day-of-year, hours, minutes, seconds, and fraction of seconds in the format of YYYYDDDHHMMSSFFF.

Orbit Stop Time (character): UTC of the end of the orbit included in the product; concatenated digits for year, day-of-year, hours, minutes, seconds, and fraction of seconds in the format of YYYYDDDHHMMSSFFF.

Product Center Time (character): start UTC of the center block of the product; concatenated digits for year, day-of-year, hours, minutes, seconds, and fraction of seconds in the format of YYYYDDHMMSSFFF.

Node Crossing Time (character): UTC of ascending node crossing; concatenated digits for year, day-of-year, hours, minutes, seconds, and fraction of seconds in the format of YYYYDDHMMSSFFF.

Start Year (4-byte integer): UTC year of first block of the product.

Start Day (4-byte integer): UTC day-of-year of first block of the product.

Start Millisec (4-byte integer): UTC milliseconds-of-day of the first block of the product.

End Year (4-byte integer): UTC year of last block of the product.

End Day (4-byte integer): UTC day-of-year of last block of the product.

End Millisec (4-byte integer): UTC milliseconds-of-day of the last block of the product.

Orbit Number (4-byte integer): orbit number starting at the **Node Crossing Time**.

Orbit Node Longitude (4-byte real): longitude of product's orbit ascending node (longitude at equatorial crossing of PM-side node).

Cycle Number (4-byte integer): number of the weekly cycle from the start of the mission; started at the date given by the **Cycle Start Time**. Cycle 1 will be defined at the start of science data collection; all data collected during the Aquarius commissioning phase will be indicated as Cycle 0. Each cycle will contain 103 orbits.

Pass Number (4-byte integer): pass (orbit) number within the weekly cycle (1 to 103).

3.3 Data Characteristics

See the Aquarius Instrument to Aquarius Ground System Interface document for explanations of characteristics in the data packet.

Number of Blocks (4-byte integer): number of Aquarius science blocks in the product at 1.44 second intervals.

Number of RAD Frames (4-byte integer): number of radiometer frames in the product at 5.76 second intervals.

Number of ATC Frames (4-byte integer): number of ATC telemetry frames in the product at 5.76 second intervals.

Missing Blocks (4-byte integer): missing blocks count in the product.

Number of Beams (4-byte integer): 3; number of antenna beams.

Radiometer Polarizations (4-byte integer): 4; order is V, +45, -45, H

Radiometer Subcycles (4-byte integer): 12; the number of 120 msec radiometer subcycles in a 1.44 second science block.

Radiometer Signals per Subcycle (4-byte integer): 5; the number of radiometer antenna measurements stored in the science block in each 120-msec subcycle.

Radiometer Long Accumulations (4-byte integer): 8; see TBD for explanation.

Scatterometer Polarizations (4-byte integer): 6; order is HV, nV, VV, VH, nH, HH.

Scatterometer Subcycles (4-byte integer): 8; the number of 180 msec scatterometer subcycles in a 1.44 second science block.

Number of Orbit Vectors (4-byte integer): number of sets of SAC-D orbit position and velocity vectors in the product.

Number of Attitude Samples (4-byte integer): number of samples of attitude data in the product (note that this will be the same as **Number of SAC-D HKT** if the attitude quaternions are obtained from the SAC-D HKT, and different if another source is used).

3.4 File Metrics

Radiometer LUTs Block Count (4-byte integer, array size 8): number of science blocks for which the radiometer look-up table (LUT) is set to each LUT number, with the array index (0 through 7) corresponding to the LUT number; this is based on the value of the OpLUT for each block (see Section 4.5 and **dpu_status_tlm**).

Percent Non-default Radiometer LUTs (4-byte real): percent of science blocks for which the radiometer LUT is set to a value other than 0 (default); any value other than 0 can not be processed as normal science data.

4 Data Objects

The following groups contain attributes computed for each science block; all of the raw Aquarius data, including the header and footer, the raw housekeeping telemetry (HKT), radiometer and scatterometer science data; SAC-D HKT that are needed to process the data, from the files provided by CONAE; the navigation data for this orbit, consisting of the SAC-D orbit and attitude data, from the ephemeris and HKT files provided by CONAE; and the Aquarius HKT converted to engineering units.

4.1 Block Attributes

The following data objects are SDSs belonging to the group "Block Attributes". Attributes of the SDSs are shown in **bold**.

blk_sec (8-byte real, array size **Number of Blocks**): **long_name** = "Block time, seconds of day"; **valid_range** = (0.d0,86399.99999d0); **units** = "seconds".

atc_frmnum (4-byte integer, array size **Number of Blocks**): **long_name** = "ATC Frame Number".

atc_subframe (byte, array size **Number of Blocks**): **long_name** = "ATC Sub-Frame Number".

rad_frmnum (4-byte integer, array size **Number of Blocks**): **long_name** = "Radiometer Frame Number"; radiometer frame number corresponding to each block time.

rad_subframe (byte, array size **Number of Blocks**): **long_name** = "Radiometer Sub-Frame Number"; radiometer subframe number corresponding to each block time.

4.2 Raw Aquarius Data

The following data objects belong to the group "Raw Aquarius Data". Attributes of the objects are shown in **bold**. Telemetry definitions are given in the Aquarius Instrument to Aquarius Ground System Interface document.

4.2.1 Block Header and Footer

gps_time_tag (4-byte integer, array size **Number of Blocks**): **long_name** = "Block GPS time tag"; GPS time tag after Aquarius block time; TAI seconds since 0 UTC 6 January 1980.

time_tag_offset (4-byte integer, array size **Number of Blocks**): **long_name** = "Block time offset from GPS"; time offset from Aquarius block time to **gps_time_tag**, in units of 62.5 nanoseconds. Note that the value in the Aquarius science block is greater by 2 counts than the actual time offset, so the values in this object have been corrected by 2 counts.

start_synch (4-byte integer, array size **Number of Blocks**): **long_name** = "Start-synch word"; synch word that indicates the start of the science block, fixed value of hex 'deadbeef'.

pad (byte, array size 35): **long_name** = "Pad bytes"; fill data not otherwise allocated in the 2560-byte science block.

checksum (2-byte integer, array size **Number of Blocks**): **long_name** = "Checksum"; two-byte checksum at the end of the science block.

4.2.2 Aquarius Raw Telemetry

deploy_tlm (byte, array size **Number of Blocks** x 5): **long_name** = "Antenna deployment telemetry"; raw deployment telemetry data.

icds_status (byte, array size **Number of Blocks** x 12): **long_name** = "ICDS processing status"; raw ICDS status data.

icds_tlm (byte, array size **Number of Blocks** x 24): **long_name** = "ICDS engineering telemetry"; raw ICDS telemetry data.

temp_tlm (byte, array size **Number of Blocks** x 70): **long_name** = External Temperature Sensors telemetry"; raw external temperature sensor telemetry data.

apdu_tlm (byte, array size **Number of Blocks** x 5): **long_name** = "Aquarius Power Distribution Unit telemetry"; raw APDU telemetry data.

atc_tlm (byte, array size **Number of ATC Frames** x 4 x 36): **long_name** = "Automatic Temperature Control Unit telemetry"; raw ATC telemetry data, subcommutated over 4 blocks.

radiom_rt_tlm (byte, array size **Number of RAD Frames** x 4 x 50): **long_name** = "Radiometer real-time telemetry"; raw radiometer real-time housekeeping telemetry data, subcommutated over 4 blocks; see TBD for contents.

radiom_nrt_tlm (byte, array size **Number of RAD Frames** x 4 x 10): **long_name** = "Radiometer non-real-time telemetry"; raw radiometer non-real-time housekeeping telemetry data; see TBD for contents.

scatter_tlm (byte, array size **Number of Blocks** x 37): **long_name** = "Scatterometer telemetry"; raw scatterometer housekeeping telemetry data.

4.2.3 Raw Radiometer Science Data

The raw radiometer data in the Level-1A product are indexed by frame, where each frame contains 4 blocks. Any blocks in the frame that precede the start time of the file will be zero filled. The valid data are located using the **rad_frmnum** and **rad_subframe** data objects to index the first and second dimension, respectively, of each data object in this group.

radiom_header (2-byte integer, array size **Number of RAD Frames** x 4): **long_name** = "Radiometer block header"; this header specifies the packet type (standard or memory dump) and housekeeping telemetry packet number (0 through 3).

radiom_signals (2-byte integer, array size **Number of RAD Frames** x 4 x **Radiometer Subcycles** x **Radiometer Antenna Looks per Subcycle** x **Number of Beams** x **Radiometer Polarizations**): **long_name** = "Radiometer Antenna Looks"; radiometer antenna signals accumulated and averaged within a subcycle.

radiom_cnd (2-byte integer, array size **Number of RAD Frames** x 4 x **Radiometer Subcycles** x **Number of Beams** x **Radiometer Polarizations**): **long_name** = "Radiometer CND Looks"; radiometer CND data for each subcycle.

radiom_lavg (2-byte integer, array size **Number of RAD Frames** x 4 x **Radiometer Long Accumulations** x **Number of Beams** x **Radiometer Polarizations**): **long_name** = "Radiometer Long Accumulations"; radiometer data accumulated and averaged over multiple subcycles within a block.

4.2.4 Raw Scatterometer Science Data

scatter_headers (byte, array size **Number of Blocks** x **Scatterometer Subcycles**): **long_name** = "Scatterometer subcycle headers"; headers for each scatterometer subcycle within a block.

scatter_pwr (2-byte integer, array size **Number of Blocks** x **Scatterometer Subcycles** x **Number of Beams** x **Scatterometer Polarizations**): **long_name** = "Scatterometer Power"; raw scatterometer power data for each subcycle within a block.

scatter_loop (2-byte integer, array size **Number of Blocks** x **Number of Beams** x **Scatterometer Polarizations**): **long_name** = "Scatterometer Loopback Measurements"; scatterometer loopback data average over the subcycles within a block.

scatter_dc (2-byte integer, array size **Number of Blocks** x 2): **long_name** = "Scatterometer DC data"; raw scatterometer DC data averaged over the subcycles within a block.

scatter_rfi (byte, array size **Number of Blocks** x 4): **long_name** = "Scatterometer RFI flags for H-pol"; scatterometer detected RFI flag; 1st byte set to hex 'ad' if the RFI patch is loaded; 2nd through 4th bytes contain flags for each beam, one bit per subcycle for the H-pol channel of each beam, set to 1 if RFI is present.

4.3 SAC-D Telemetry

The following data objects belong to the group "SAC-D Telemetry". Attributes of the objects are shown in **bold**.

sacd_hkt (byte, array size 1040 x 4000): **long_name** = "SAC-D raw housekeeping telemetry blocks"; raw service platform housekeeping telemetry, provided in 4000-byte binary data blocks every 8 seconds.

4.4 Navigation

The following data objects belong to the group "Navigation". Attributes of the objects are shown in **bold**.

orb_time (8-byte real, array size **Number of Orbit Vectors**): **long_name** = "Time tag of orbit vectors"; time of day of the orbit vectors; **valid_range** = (0, 86,399.999); **units** = "seconds".

orb_pos (8-byte real, array size **Number of Orbit Vectors** x 3): **long_name** = "Orbital position vector"; orbit position vectors in the J2000 reference frame; **valid_range** = (-7100000., 7100000.); **units** = "meters"; used to determine spacecraft position for geolocation.

orb_vel (8-byte real, array size **Number of Orbit Vectors** x 3): **long_name** = "Orbital velocity vector"; orbit velocity vectors in the J2000 reference frame; **valid_range** = (-7600., 7600.); **units** = "meters per second"; used to determine spacecraft position for geolocation.

att_time (8-byte real, array size **Number of Attitude Samples**): **long_name** = "Time tag of attitude data"; time of day of the attitude angles and quaternions; **valid_range** = (0, 86,399.999); **units** = "seconds".

att_ang (8-byte real, array size **Number of Attitude Samples** x 3): **long_name** = "Spacecraft roll, pitch, yaw"; **valid_range** = (-180.,180.); spacecraft attitude Euler angles at attitude times; relates spacecraft orientation to orbit reference frame.

quaternion (8-byte real, array size **Number of Attitude Samples** x 4): **long_name** = "ECI-to-spacecraft quaternion"; **valid_range** = (-1.,1.); spacecraft attitude quaternion at attitude times; relates spacecraft frame to Earth-fixed inertial (J2000) reference frame.

att_flags (4-byte integer, array size **Number of Attitude Samples**): **long_name** = "Attitude flags"; first byte set to 1 indicates Cold Sky Calibration maneuver in progress.

4.5 Converted Telemetry

The following data objects belong to the group "Converted Telemetry". Attributes of the objects are shown in **bold**. This group contains Aquarius housekeeping telemetry that have been unpacked and (for analog fields) converted to physical units.

rfe1_analog_tlm (4-byte real, array size **Number of RAD Frames** x 23): **long_name** = "RFE1 analog telemetry"; unpacked and converted analog housekeeping telemetry for radiometer front end 1; see Table 1 for list of fields.

- rfe2_analog_tlm** (4-byte real, array size **Number of RAD Frames** x 23): **long_name** = "RFE2 analog telemetry"; unpacked and converted analog housekeeping telemetry for radiometer front end 2; see Table 1 for list of fields.
- rfe3_analog_tlm** (4-byte real, array size **Number of RAD Frames** x 23): **long_name** = "RFE3 analog telemetry"; unpacked and converted analog housekeeping telemetry for radiometer front end 3; see Table 1 for list of fields.
- rbe1_analog_tlm** (4-byte real, array size **Number of RAD Frames** x 21): **long_name** = "RBE1 analog telemetry"; unpacked and converted analog housekeeping telemetry for radiometer back end 1; see Table 2 for list of fields.
- rbe2_analog_tlm** (4-byte real, array size **Number of RAD Frames** x 21): **long_name** = "RBE2 analog telemetry"; unpacked and converted analog housekeeping telemetry for radiometer back end 2; see Table 2 for list of fields.
- rbe3_analog_tlm** (4-byte real, array size **Number of RAD Frames** x 21): **long_name** = "RBE3 analog telemetry"; unpacked and converted analog housekeeping telemetry for radiometer back end 3; see Table 2 for list of fields.
- dpu_analog_tlm** (4-byte real, array size **Number of RAD Frames** x 12): **long_name** = "DPU analog telemetry", unpacked and converted analog housekeeping telemetry for the radiometer DPU; see Table 3 for list of fields.
- dpu_status_tlm** (byte, array size **Number of RAD Frames** x 4 x 13): **long_name** = "DPU discrete telemetry", unpacked discrete housekeeping telemetry for the radiometer DPU; see Table 4 for list of fields.
- radiom_nrt_tlm** (2-byte integer, array size **Number of RAD Frames** x 4 x 17): **long_name** = "Radiometer discrete non-real-time telemetry"; unpacked radiometer non-real-time housekeeping telemetry data; see Table 5 for contents.
- scatter_analog_tlm** (4-byte real, array size **Number of Blocks** x 30): **long_name** = "Scatterometer analog telemetry", unpacked and converted analog housekeeping telemetry for the scatterometer; see Table 6 for list of fields.
- scatter_discrete_tlm** (byte, array size **Number of Blocks** x 8): **long_name** = "Scatterometer discrete telemetry", unpacked discrete housekeeping telemetry for the scatterometer; see Table 7 for list of fields.
- ext_temp_analog_tlm** (4-byte real, array size **Number of Blocks** x 38): **long_name** = "External Temperature Sensors analog telemetry"; unpacked and converted external temperature sensor analog telemetry data; see Table 8 for list of fields.
- deploy_analog_tlm** (4-byte real, array size **Number of Blocks** x 4): **long_name** = "Antenna deployment analog telemetry"; unpacked and converted deployment analog telemetry; see Table 9 for list of fields.
- deploy_discrete_tlm** (4-byte integer, array size **Number of Blocks** x 7): **long_name** = "Antenna deployment discrete telemetry"; unpacked deployment discrete telemetry; see Table 10 for list of fields.
- icds_analog_tlm** (4-byte integer, array size **Number of Blocks** x 14): **long_name** = "ICDS analog telemetry"; unpacked and converted ICDS analog telemetry; see Table 11 for list of fields.

icds_discrete_tlm (4-byte integer, array size **Number of Blocks** x 8): **long_name** = "ICDS discrete telemetry"; unpacked ICDS discrete telemetry; see Table 12 for list of fields.

apdu_analog_tlm (4-byte real, array size **Number of Blocks** x 5): **long_name** = "Aquarius Power Distribution Unit analog telemetry"; unpacked and converted APDU analog telemetry; see Table 13 for list of fields.

atc_omt1_analog_tlm (4-byte real, array size **Number of ATC Frames** x 17): **long_name** = "ATC OMT1 analog telemetry"; unpacked and converted Automatic Temperature Control OMT1 analog telemetry; see Table 14 for list of fields.

atc_omt2_analog_tlm (4-byte real, array size **Number of ATC Frames** x 17): **long_name** = "ATC OMT2 analog telemetry"; unpacked and converted Automatic Temperature Control OMT2 analog telemetry; see Table 14 for list of fields.

atc_omt3_analog_tlm (4-byte real, array size **Number of ATC Frames** x 17): **long_name** = "ATC OMT3 analog telemetry"; unpacked and converted Automatic Temperature Control OMT3 analog telemetry; see Table 14 for list of fields.

atc_rbe_analog_tlm (4-byte real, array size **Number of ATC Frames** x 17): **long_name** = "ATC RBE analog telemetry"; unpacked and converted Automatic Temperature Control RBE analog telemetry; see Table 15 for list of fields.

atc_omt1_discrete_tlm (byte, array size **Number of ATC Frames** x 17): **long_name** = "ATC OMT1 discrete telemetry"; unpacked Automatic Temperature Control OMT1 discrete telemetry; see Table 16 for list of fields.

atc_omt2_discrete_tlm (byte, array size **Number of ATC Frames** x 17): **long_name** = "ATC OMT2 discrete telemetry"; unpacked Automatic Temperature Control OMT1 discrete telemetry; see Table 16 for list of fields.

atc_omt3_discrete_tlm (byte, array size **Number of ATC Frames** x 17): **long_name** = "ATC OMT3 discrete telemetry"; unpacked Automatic Temperature Control OMT1 discrete telemetry; see Table 16 for list of fields.

atc_rbe_discrete_tlm (byte, array size **Number of ATC Frames** x 17): **long_name** = "ATC RBE discrete telemetry"; unpacked Automatic Temperature Control RBE discrete telemetry; see Table 17 for list of fields.

Table 1 -- Radiometer RFE Analog Telemetry (same for RFE1, RFE2, RFE3)

Index	Mnemonic(*)	Description	Units	Range
1	RD_RFEn_CBPT	RFEn Cntl Bd Pwr Temp	Deg C	
2	RD_RFEn_CBT	RFEn Cntl Bd Temp	Deg C	
3	RD_RFEn_CNDNDT	RFEn CND ND Temp	Deg C	
4	RD_RFEn_HDL1TN	RFEn Horiz Dicke Load 1 Temp-	Deg C	
5	RD_RFEn_HDL1TP	RFEn Horiz Dicke Load 1 Temp+	Deg C	
6	RD_RFEn_HDL2T	RFEn Horiz Dicke Load 2 Temp	Deg C	

7	RD_RFEn_HLNAT	RFEn Horiz LNA Temp	Deg C	
8	RD_RFEn_HNDTN	RFEn Horiz ND Temp-	Deg C	
9	RD_RFEn_HNDTP	RFEn Horiz ND Temp+	Deg C	
10	RD_RFEn_VDL1TN	RFEn Vert Dicke Load 1 Temp-	Deg C	
11	RD_RFEn_VDL1TP	RFEn Vert Dicke Load 1 Temp+	Deg C	
12	RD_RFEn_VDL2T	RFEn Vert Dicke Load 2 Temp	Deg C	
13	RD_RFEn_VLNAT	RFEn Vert LNA Temp	Deg C	
14	RD_RFEn_VNDTN	RFEn Vert ND Temp-	Deg C	
15	RD_RFEn_VNDTP	RFEn Vert ND Temp+	Deg C	
16	RD_RFEn_CNDI	RFEn CND Current	mA	
17	RD_RFEn_HNDI	RFEn HND Current	mA	
18	RD_RFEn_VNDI	RFEn VND Current	mA	
19	RD_RFEn_12N	RFEn -12vdc Sense	Volts	
20	RD_RFEn_12P	RFEn +12vdc Sense	Volts	
21	RD_RFEn_15P	RFEn +15vdc Sense	Volts	
22	RD_RFEn_5D	RFEn 5vdc_D Sense	Volts	
23	RD_RFEn_5RF	RFEn 5vdc_RF Sense	Volts	

(*) n = 1, 2, 3 for RFE1, RFE2, RFE3

Table 2 -- Radiometer RBE Analog Telemetry (same for RBE1, RBE2, RBE3)

Index	Mnemonic(*)	Description	Units	Range
1	RD_RBEn_CBT	RBEn Cntl Bd Temp	Deg C	
2	RD_RBEn_D_HT	RBEn Det4Temp	Deg C	
3	RD_RBEn_D_MT	RBEn Det3Temp	Deg C	
4	RD_RBEn_D_PT	RBEn Det2Temp	Deg C	
5	RD_RBEn_D_VT	RBEn Det1Temp	Deg C	
6	RD_RBEn_LNA_H1T	RBEn LNA 4-1 Temp	Deg C	
7	RD_RBEn_LNA_H2T	RBEn LNA 4-2 Temp	Deg C	
8	RD_RBEn_LNA_M1T	RBEn LNA 3-1 Temp	Deg C	
9	RD_RBEn_LNA_M2T	RBEn LNA 3-2 Temp	Deg C	
10	RD_RBEn_LNA_P1T	RBEn LNA 2-1 Temp	Deg C	
11	RD_RBEn_LNA_P2T	RBEn LNA 2-2 Temp	Deg C	
12	RD_RBEn_LNA_V1T	RBEn LNA 1-1 Temp	Deg C	
13	RD_RBEn_LNA_V2T	RBEn LNA 1-2 Temp	Deg C	
14	RD_RBEn_VCBT	RBEn Volt Cond Bd Temp	Deg C	
15	RD_RBEn_12N	RBEn -12vdc Sense	Volts	
16	RD_RBEn_12P	RBEn +12vdc Sense	Volts	
17	RD_RBEn_15N	RBEn -15vdc Sense	Volts	
18	RD_RBEn_15P	RBEn +15vdc Sense	Volts	
19	RD_RBEn_5	RBEn 5vdc Sense	Volts	
20	RD_RBEn_5RF	RBEn -12vdc Sense	Volts	

(*) n = 1, 2, 3 for RBE1, RBE2, RBE3

Table 3 -- Radiometer DPU Analog Telemetry

Index	Mnemonic	Description	Units	Range
1	RD_DPU_R1P	DPU-RefRes1+	kOhms	
2	RD_DPU_R1N	DPU-RefRes1-	kOhms	
3	RD_DPU_R2P	DPU-RefRes2+	kOhms	
4	RD_DPU_R2N	DPU-RefRes2-	kOhms	
5	RD_DPU_R3	DPU-RefRes3	kOhms	
6	RD_DPU_R1	DPU-RefRes1	kOhms	
7	RD_DPU_DT	DPU-DIG-Temp	Deg C	
8	RD_DPU_AT2	DPU_ANA_Temp2	Deg C	
9	RD_DPU_12N	DPU-12VN	Volts	
10	RD_DPU_12P	DPU-12VP	Volts	
11	RD_DPU_5P	DPU-5VP	Volts	
12	RD_DPU_I	DPU-ISRCVref	mA	

Table 4 -- Radiometer DPU Discrete Telemetry

Index	Mnemonic	Description	Bits	States
1	RD_STS_FIFO_ERR	FIFO error	1	
2	RD_STS_FIFO_ERR_VAL	FIFO error under/overflow	1	
3	RD_STS_MEM_LDG	Memory load in progress	1	
4	RD_STS_INTEG_ERR	Integration error	1	
5	RD_STS_RP_LOST_ERR	Lost receive protect	1	
6	RD_STS_FS_LOST_ERR	Lost frame synch	1	
7	RD_STS_CMD_ERR	Command error	1	
8	RD_STS_GOT_CMD	Command received	1	
9	RD_STS_UP_CHK_ERR	UpLUT checksum error	1	
10	RD_STS_OP_CHK_ERR	OpLUT checksum error	1	
11	RD_STS_OPLUT	OpLUT #	3	0 - 7
12	RD_STS_BLK_CNT	Block count	2	0 - 3
13	RD_STS_SPARE	Unused	1	

Table 5 -- Radiometer Non-Real Time Telemetry

Index	Mnemonic	Description	Bits	States
1	RD_VFA_OVRFLO	Analog Board V/F Error	1	
2	RD_EEPROM_SEL	EEPROM used for last cold reset	1	0 = primary, 1 = backup
3	RD_UPLUTNO	UpLUT #	3	
4	RD_LAST_RESET	Last reset status	2	00 = powerup, 01 = hardware reset 10=due to Load EE cmd 11=due to soft reset cmd
5	RD_HRCNT	Hardware Reset Count	4	
6	RD_CMDERR	Command Error Count	4	
7	RD_CMDCTR	Command Count	8	
8	RD_BLKCNT	Block Sequence count	8	
9	RD_VF1_ERR	V/F 1 overflow error in last block	1	
10	RD_VF2_ERR	V/F 2 overflow error in last block	1	
11	RD_VF3_ERR	V/F 3 overflow error in last block	1	
12	RD_INTEG_STRT	Integration Start	6	
13	RD_INTEG_END	Integration End	7	
14	RD_DUMPADDR	Dump Address	15	
15	RD_DUMPDATA	Dump data	16	
16	RD_SPARE1	Spare	1	
17	RD_SPARE2	Spare	1	

Table 6 -- Scatterometer Analog Telemetry

Index	Mnemonic	Description	Units	Range
1	SC_LBK_B1HV_DC	loopback B1HV DC	Volts	
2	SC_LBK_B1HV_PWR	loopback B1HV pwr	dBm	
3	SC_LVPS_BOX_TEMP	inside LVPS box temp	Deg C	
4	SC_SSPA_RF_DCK_TMP	SSPA RF deck temp	Deg C	
5	SC_SCG_TMP	SCG temp	Deg C	
6	SC_SBE_LNA_TMP	SBE LNA temp	Deg C	
7	SC_SBE_TX_CHN_TMP	SBE Tx Chain temp	Deg C	
8	SC_SBE_RX_CHN_TMP	SBE Rx Chain temp	Deg C	
9	SC_SFE_TX_LOAD_TMP	SFE Tx load temp	Deg C	
10	SC_SBE_STP_ATTEN_TMP	SBE step attenuator temp	Deg C	
11	SC_SFE_LBK_ATTEN_TMP	SFE loopback attenuator temp	Deg C	
12	SC_SFE_LBK_SW_TMP	SFE loopback switch temp	Deg C	
13	SC_SFE_BM_SW_TMP	SFE beam switch temp	Deg C	
14	SC_SFE_GND_MON	SFE ground monitor	Volts	
15	SC_SFE_N15_VLT_MON	SFE 15N voltage monitor	Volts	
16	SC_SBE_PLM1_TUNG_VLT	SBE PLM 1 tuning voltage (960)	Volts	
17	SC_SBE_PLM2_TUNG_VLT	SBE PLM 2 tuning voltage (1256)	Volts	
18	SC_8MHZ_STLO_OUT_PWR_LVL	8MHz Stalo Output Power Level	Volts	
19	SC_16MHZ_PWR_LVL	SBE 16 MHz Power Level	Volts	
20	SC_SBE_PLM1_PWR_LVL	SBE PLM1 Power Level (960)	Volts	
21	SC_SBE_PLM2_PWR_LVL	SBE PLM2 Power Level (1256)	Volts	
22	SC_SBE_TX_EXCTR_PWR_MON	SBE Tx Exciter Power Mon	Volts	
23	SC_LVPS_CNVTR_CURR	LVPS Converter Current	Amps	
24	SC_SSPA_OUTPT_STG_VLT	SSPA output stage voltage	Volts	
25	SC_SSPA_INTRM_STG_VLT	SSPA intermediate stage voltage	Volts	
26	SC_SSPA_INPT_STG_VLT	SSPA input stage voltage	Volts	
27	SC_SFE_P5V_MON	SFE +5V monitor	Volts	
28	SC_SCG_P5V_MON	SCG +5V monitor	Volts	
29	SC_SBE_P5V_MON	SBE +5V monitor	Volts	
30	SC_SBE_P12V_NSW_MON	SBE +12V monitor (non switched)	Volts	

Table 7 -- Scatterometer Discrete Telemetry

Index	Mnemonic	Description	Bits	States
1	SC_STS_FIFO_ERR	FIFO error	1	0 = nominal
2	SC_STS_FIFO_ERR_VAL	FIFO error under/overflow	1	0 = nominal
3	SC_STS_SCAT_LVPS_OVR_CUR	SSPA LVPS overcurrent flag	1	0 = nominal
4	SC_STS_SCAT_LVPS_BUS_VLT	SSPA LVPS bus undervoltage flag	1	0 = nominal
5	SC_STS_CG_LTCH_PRM	SCG latchup prime	1	0 = nominal
6	SC_STS_CG_LTCH_RED	SCG latchup redundant	1	0 = nominal
7	SC_SPARE1	Unused 1	1	
8	SC_SPARE2	Unused 2	1	

Table 8 -- External Temperature Analog Telemetry

Index	Mnemonic	Description	Units	Range
1	ET_OMT1_H_PROBE_TMP	OMT1 H-probe temp	deg C	
2	ET_OMT1_V_PROBE_TMP	OMT1 V-probe temp	deg C	
3	ET_OMT2_H_PROBE_TMP	OMT2 H-probe temp	deg C	
4	ET_OMT2_V_PROBE_TMP	OMT2 V-probe temp	deg C	
5	ET_OMT3_H_PROBE_TMP	OMT3 H-probe temp	deg C	
6	ET_OMT3_V_PROBE_TMP	OMT3 V-probe temp	deg C	
7	ET_SFE_H1_COAX_TMP	dplxr to SFE coax H1 temp	deg C	
8	ET_SFE_H2_COAX_TMP	dplxr to SFE coax H2 temp	deg C	
9	ET_SFE_H3_COAX_TMP	dplxr to SFE coax H3 temp	deg C	
10	ET_SFE_V1_COAX_TMP	dplxr to SFE coax V1 temp	deg C	
11	ET_SFE_V2_COAX_TMP	dplxr to SFE coax V2 temp	deg C	
12	ET_SFE_V3_COAX_TMP	dplxr to SFE coax V3 temp	deg C	
13	ET_DPLX_1H_TMP	diplexer 1H temp	deg C	
14	ET_DPLX_1V_TMP	diplexer 1V temp	deg C	
15	ET_DPLX_2H_TMP	diplexer 2H temp	deg C	
16	ET_DPLX_2V_TMP	diplexer 2V temp	deg C	
17	ET_DPLX_3H_TMP	diplexer 3H temp	deg C	
18	ET_DPLX_3V_TMP	diplexer 3V temp	deg C	
19	ET_CPLR_1H_TMP	coupler 1H temp	deg C	
20	ET_CPLR_1V_TMP	coupler 1V temp	deg C	
21	ET_CPLR_2H_TMP	coupler 2H temp	deg C	
22	ET_CPLR_2V_TMP	coupler 2V temp	deg C	
23	ET_CPLR_3H_TMP	coupler 3H temp	deg C	
24	ET_CPLR_3V_TMP	coupler 3V temp	deg C	
25	ET_CND1_TMP	CND1 temp	deg C	
26	ET_CND2_TMP	CND2 temp	deg C	
27	ET_CND3_TMP	CND3 temp	deg C	
28	ET_RFL1_TMP	reflector1 temp	deg C	
29	ET_RFL2_TMP	reflector2 temp	deg C	
30	ET_RFL3_TMP	reflector3 temp	deg C	
31	ET_RFL4_TMP	reflector4 temp	deg C	
32	ET_RFL5_TMP	reflector5 temp	deg C	
33	ET_RFL6_TMP	reflector6 temp	deg C	
34	ET_RFL7_TMP	reflector7 temp	deg C	
35	ET_RFL8_TMP	reflector8 temp	deg C	
36	ET_FD1_TMP	feed1 temp	deg C	
37	ET_FD2_TMP	feed2 temp	deg C	
38	ET_FD3_TMP	feed3 temp	deg C	

Table 9 -- Deployment Analog Telemetry

Index	Mnemonic	Description	Units	Range
1	DP_UP_MEC_TMP_PRI_CAL	UDM primary cal temp	Deg C	
2	DP_UP_MEC_TMP_RED_CAL	UDM redundant cal temp	Deg C	
3	DP_LO_MEC_TMP_PRI_CAL	LDM primary cal temp	Deg C	
4	DP_LO_MEC_TMP_RED_CAL	LDM redundant cal temp	Deg C	

Table 10 -- Deployment Discrete Telemetry

Index	Mnemonic	Description	Bits	States
1	DP_SEP1_STW	sep1 stowed	1	0= stowed
2	DP_SEP2_STW	sep2 stowed	1	0= stowed
3	DP_LDM_STW	LDM stowed	1	0= stowed
4	DP_UDM_PRI_LATCH	UDM_latched	1	1= latched
5	DP_UDM_RED_DEPL	UDM_deployed	1	1= deployed
6	DP_LDM_PRI_LATCH	LDM_latched	1	1= latched
7	DP_LDM_RED_DEPL	LDM_deployed	1	1= deployed

Table 11 -- ICDS Analog Telemetry

Index	Mnemonic	Description	Units	Range
1	IE_ICDS_P5V	ICDS +5v	volts	
2	IE_ICDS_P15V	ICDS +15v	volts	
3	IE_ICDS_N15V	ICDS -15v	volts	
4	IE_SCI_ADC_5VA	sci ADC 5VA	volts	
5	IE_SCI_ADC_VREF	sci ADC VREF	volts	
6	IE_SCI_ADC_TMP	sci ADC temperature	deg C	
7	IE_ICDS_TMP_CHASS	ICDS temp chassis	deg C	
8	IE_ICDS_TMP_RAD6K	ICDS temp Rad6000	deg C	
9	IE_ICDS_TMP_ATC1	ICDS temp ATC 1	deg C	
10	IE_ICDS_TMP_ATC2	ICDS temp ATC 2	deg C	
11	IE_ICDS_TLM_CAL_RES1	ICDS telem board cal resistor 1	ohms	
12	IE_ICDS_TLM_CAL_RES2	ICDS telem board cal resistor 2	ohms	
13	IE_ICDS_TLM_CAL_RES3	ICDS telem board cal resistor 3	ohms	
14	IE_ICDS_TLM_CAL_RES4	ICDS telem board cal resistor 4	ohms	

Table 12 -- ICDS Discrete Telemetry

Index	Mnemonic	Description	Bits	States
1	IP_GPS_TIME_LST_BOOT	GPS Time of Last Boot	32	
2	IP_CMD_RCVD_CNT	Command received counter	16	
3	IP_LAST_CMD_RCVD_ID	Last command received ID	16	
4	IP_LST_BLK_NUM	Last block number	32	
5	IE_ICDS_ROT_REG_ID	Rotating register ID	8	1=MODEA 2=MODEB 3=HRLY 4=PRLY(3) 5=STAT 6=FIFO_RST 7=RAD_RST 8=CG_RST 9=FPGA_RST 10=RXST1 11=RXST2 12=RXST3 13=RXLEN1 14=RXLEN2 15=RXLEN3 16=RADCMD 17=RFL 18=RCE 19= sci_dat_fifo_sel
6	IE_ICDS_ROT_REG_VAL	Rotating register value	16	
7	IE_ICDS_SEL_REG_ID	Selected register ID	8	See above
8	IE_ICDS_SEL_REG_VAL	selected register value	16	

Table 13 -- APDU Analog Telemetry

Index	Mnemonic	Description	Units	Range
1	AP_ATC_TMP	APDU ATC temp	Deg C	
2	AP_RFE_TMP	APDU RFE temp	Deg C	
3	AP_RBE_DPU_TMP	APDU RBE/DPU temp	Deg C	
4	AP_SCAT_TMP	APDU Scatterometer temp	Deg C	
5	AP_ICDS_TMP	APDU ICDS temp	Deg C	

Table 14 -- ATC Analog Telemetry (same for OMT1, OMT2, OMT3)

Index	Mnemonic (*)	Description (*)	Units	Range
1	AT_OMTn_PRT1_PRM_CTL_TMP	OMT n Primary Control Temp (PRT1)	deg C	
2	AT_OMTn_PRT2_H_PRBCX_TMP	OMT n H-probe Coax Temp (PRT2)	deg C	
3	AT_OMTn_PRT3_OMTNECK_TMP	OMT n OMT Neck Temp (PRT3)	deg C	
4	AT_OMTn_PRT4_REDUN_CTL_TMP	OMT n Redundant Control Temp (PRT4)	deg C	
5	AT_OMTn_PRT5_V_PRBCX_TMP	OMT n V-probe Coax Temp (PRT5)	deg C	
6	AT_OMTn_PRT6_OMT_TMP	OMT n OMT Structure Temp (PRT6)	deg C	
7	AT_OMTn_TMP_CTL_STPT_RDBK	OMT n Temp Control Setpoint Readback	deg C	
8	AT_OMTn_PID_PROP_RDBK	OMT n PID Readback, Proportion	W / deg C	
9	AT_OMTn_PID_INTEG_RDBK	OMT n PID Readback, Integral	W / deg C / sec	
10	AT_OMTn_PID_DERIV_RDBK	OMT n PID Readback, Derivative	W sec / deg C	
11	AT_OMTn_CMP_PROP	OMT n Computed Proportion	W	
12	AT_OMTn_CMP_INTEG	OMT n Computed Integral	W	
13	AT_OMTn_CMP_DERIV	OMT n Computed Derivative	W	
14	AT_OMTn_HTR_PWR_OFFST	OMT n Heater power offset readback	W	
15	AT_OMTn_HTR_TOT_PWR	OMT n Heater total power output	W	
16	AT_OMTn_HTR_PWR_OFFST_PRCNT	OMT n Heater power offset readback (percent)	%	
17	AT_OMTn_HTR_TOT_PWR_PRCNT	OMT n Heater total power output (percent)	%	

(*) n = 1, 2 or 3 for OMT1, OMT2, OMT3

Table 15 -- ATC Analog Telemetry (RBE)

Index	Mnemonic	Description	Units	Range
1	AT_RBE_PRT1_PRM_CTL_TMP	RBE Primary Control Temp (PRT1)	deg C	
2	AT_RBE_PRT2_RBE_TMP	RBE Temp (PRT2)	deg C	
3	AT_RBE_PRT3_SFE_TMP	RBE SFE/BER Temp (PRT3)	deg C	
4	AT_RBE_PRT4_REDUN_CTL_TMP	RBE Redundant Control Temp (PRT4)	deg C	
5	AT_RBE_PRT5_SBE_TMP	RBE SBE/SFE Temp (PRT5)	deg C	
6	AT_RBE_PRT6_SCG_TMP	RBE SCG/RBE Temp (PRT6)	deg C	
7	AT_RBE_TMP_CTL_STPT_RDBK	RBE Temp Control Setpoint Readback	deg C	
8	AT_RBE_PID_PROP_RDBK	RBE PID Readback, Proportion	W / deg C	
9	AT_RBE_PID_INTEG_RDBK	RBE PID Readback, Integral	W / deg C / sec	
10	AT_RBE_PID_DERIV_RDBK	RBE PID Readback, Derivative	W sec / deg C	
11	AT_RBE_CMP_PROP	RBE Computed Proportion	W	
12	AT_RBE_CMP_INTEG	RBE Computed Integral	W	
13	AT_RBE_CMP_DERIV	RBE Computed Derivative	W	
14	AT_RBE_HTR_PWR_OFFST	RBE Heater power offset readback	W	
15	AT_RBE_HTR_TOT_PWR	RBE Heater total power output	W	
16	AT_RBE_HTR_PWR_OFFST_PRCNT	RBE Heater power offset readback (percent)	%	
17	AT_RBE_HTR_TOT_PWR_PRCNT	RBE Heater total power output (percent)	%	

Table 16 -- ATC Discrete Telemetry (same for OMT1, OMT2, OMT3)

Index	Mnemonic (*)	Description (*)	Bits	States
1	AT_OMTn_ST_3LSB_BLK_ID	OMT n Block ID LSBs (FSW)	3	
2	AT_OMTn_ST_ACTIVE_SNSR	OMT n Active sensor	1	0=primary 1=redundant
3	AT_OMTn_ST_CMD_ERR_FG	OMT n Command error	1	0=nominal
4	AT_OMTn_ST_ADC_LTCH	OMT n ADC latch up	1	0=nominal
5	AT_OMTn_ST_ADC1_OVR_MX	OMT n Over max current ADC1	1	0=nominal
6	AT_OMTn_ST_ADC2_OVR_MX	OMT n Over max current ADC2	1	0=nominal
7	AT_OMTn_ST_FEW_TMP_FLT_FL	OMT n Temp filter failure: few (1-15)	1	0=nominal
8	AT_OMTn_ST_MANY_TMP_FLT_FL	OMT n Temp filter failure: majority (>15 of 32)	1	0=nominal
9	AT_OMTn_ST_ADC_RST	OMT n ADC reset occurrence	1	0=nominal
10	AT_OMTn_ST_WD_RST	OMT n Watchdog reset occurrence	1	0=nominal
11	AT_OMTn_ST_HRD_RST	OMT n Hard reset occurrence	1	0=nominal
12	AT_OMTn_ST_SFT_RST	OMT n Soft reset occurrence	1	0=nominal
13	AT_OMTn_ST_ADC_TOUT	OMT n ADC Timeout Error	1	0=nominal
14	AT_OMTn_ST_WD_RST_ENA	OMT n Watchdog Reset Enabled	1	0=nominal
15	AT_OMTn_ST_ADC1_PWRD	OMT n Powered ADC1	1	1=nominal
16	AT_OMTn_ST_ADC2_PWRD	OMT n Powered ADC2	1	1=nominal
17	AT_OMTn_ST_AUTOPRT_ENA	OMT n Autoprotect Enabled	1	

(*) n = 1, 2 or 3 for OMT1, OMT2, OMT3

Table 17 -- ATC Discrete Telemetry (RBE)

Index	Mnemonic	Description	Bits	States
1	AT_RBE_ST_3LSB_BLK_ID	RBE Block ID LSBs (FSW)	3	
2	AT_RBE_ST_ACTIVE_SNSR	RBE Active sensor	1	0=primary 1=redundant
3	AT_RBE_ST_CMD_ERR_FG	RBE Command error	1	0=nominal
4	AT_RBE_ST_ADC_LTCH	RBE ADC latch up	1	0=nominal
5	AT_RBE_ST_ADC1_OVR_MX	RBE Over max current ADC1	1	0=nominal
6	AT_RBE_ST_ADC2_OVR_MX	RBE Over max current ADC2	1	0=nominal
7	AT_RBE_ST_FEW_TMP_FLT_FL	RBE Temp filter failure: few (1-15)	1	0=nominal
8	AT_RBE_ST_MANY_TMP_FLT_FL	RBE Temp filter failure: majority (>15 of 32)	1	0=nominal
9	AT_RBE_ST_ADC_RST	RBE ADC reset occurrence	1	0=nominal
10	AT_RBE_ST_WD_RST	RBE Watchdog reset occurrence	1	0=nominal
11	AT_RBE_ST_HRD_RST	RBE Hard reset occurrence	1	0=nominal
12	AT_RBE_ST_SFT_RST	RBE Soft reset occurrence	1	0=nominal
13	AT_RBE_ST_ADC_TOUT	RBE ADC Timeout Error	1	0=nominal
14	AT_RBE_ST_WD_RST_ENA	RBE Watchdog Reset Enabled	1	0=nominal
15	AT_RBE_ST_ADC1_PWRD	RBE Powered ADC1	1	1=nominal
16	AT_RBE_ST_ADC2_PWRD	RBE Powered ADC2	1	1=nominal
17	AT_RBE_ST_AUTOPRT_ENA	RBE Autoprotect Enabled	1	