Constellation
Level-1C Product Format

Version 2.0

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Japan Aerospace Exploration Agency

Revision history

revision	date	section	content, reason
Version 1.0	Sept. 2nd 2014	ALL	New
Version 2.0	May. 9th 2017	Chapter 2	Reflect the format change of 1CTMI due to GPM V5 products version up.

Reference

(1) PRECIPITATION PROCESSING SYSTEM GLOBAL PRECIPITATION MEASUREMENT “File Specification for GPM Products”

(2) PRECIPITATION PROCESSING SYSTEM GLOBAL PRECIPITATION MEASUREMENT “Metadata for GPM Products”

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1. 1CGMI – GPM Common Calibrated Brightness Temperature

1.1. Data Format Structure

1.1.1. Dimension definition

Dimension definitions:

- nscan1
  - var Typical number of Swath S1 scans in the granule.
- nchannel1
  - 9 Number of Swath S1 channels (10V 10H 19V 19H 23V 37V 37H 89V 89H).
- npixel1
  - 221 Number of Swath S1 pixels in one scan.
- nchUIA1
  - 1 Number of Swath S1 unique incidence angles.
- nscan2
  - var Typical number of Swath S2 scans in the granule.
- nchannel2
  - 4 Number of Swath S2 channels (165V 165H 183+/-3V 183+/-8V).
- npixel2
  - 221 Number of Swath S2 pixels in one scan.
- nchUIA2
  - 1 Number of Swath S2 unique incidence angles.

1.1.2. Data Format Structure for 1CGMI – GPM Common Calibrated Brightness Temperature

1CGMI contains common calibrated brightness temperatures from the GMI passive microwave instrument flown on the GPM satellite. 1C-R GMI is a remapped version of 1CGMI which is explained at the end of this section. Swath S1 has 9 channels which are similar to TRMM TMI (10V 10H 19V 19H 23V 37V 37H 89V 89H). Swath S2 has 4 channels similar to AMSU-B (165V 165H 183+/-3V 183+/-8V). Data for both swaths is observed in the same revolution of the instrument.

Earth observations are taken during a segment of the rotation when GMI is looking in the +x direction of the GPM satellite. Since the spacecraft turns around every few weeks, +x may be forward or aft. We define the spacecraft axis v, used in the definition of the variable SCorientation, at the center of this segment and the same as the +x direction.

32rpm * 1min/60s * 5538s/orbit = 2954 scans / orbit.

RELATION BETWEEN THE SWATHS: Swath S2 has the same number of scans and the same number of pixels as Swath S1. Each S1 scan contains 9 channels sampled 221 times along the scan. Each S2 scan contains 4 channels sampled 221 times along the scan. Since the incidence angle of Swath S1 is different than Swath S2, the geolocations of the pixel centers are different.

1C-R GMI is a remapped version of 1CGMI. 1C-R is the input for Gprof. The 1C-R Swath S1 is the same as the 1C Swath S1. However, the 1C-R Swath S2 consists of pixels selected from 1C Swath S2 to be as close as possible to the S1 pixels. The 1C-R S2 pixels will often be observed at a different scantime and sometimes from a different granule than the corresponding S1 pixel. Since 1C S2 is narrower than 1C S1, 1C-R S2 has missing pixels on both edges of the swath.

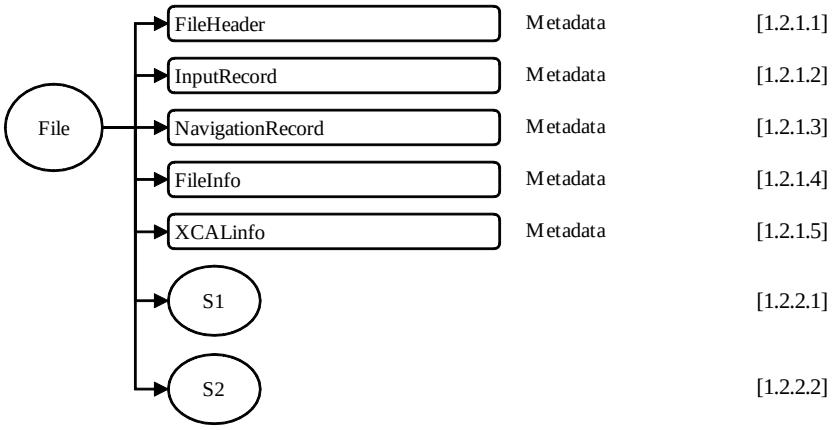

Figure 1.1-1 Data Format Structure for 1CGMI – GPM Common Calibrated Brightness Temperature

1.1.3. Data Format Structure for each Group

1.1.3.1 Data Format Structure for S1 Group

S1 Group's structure is shown in this section.

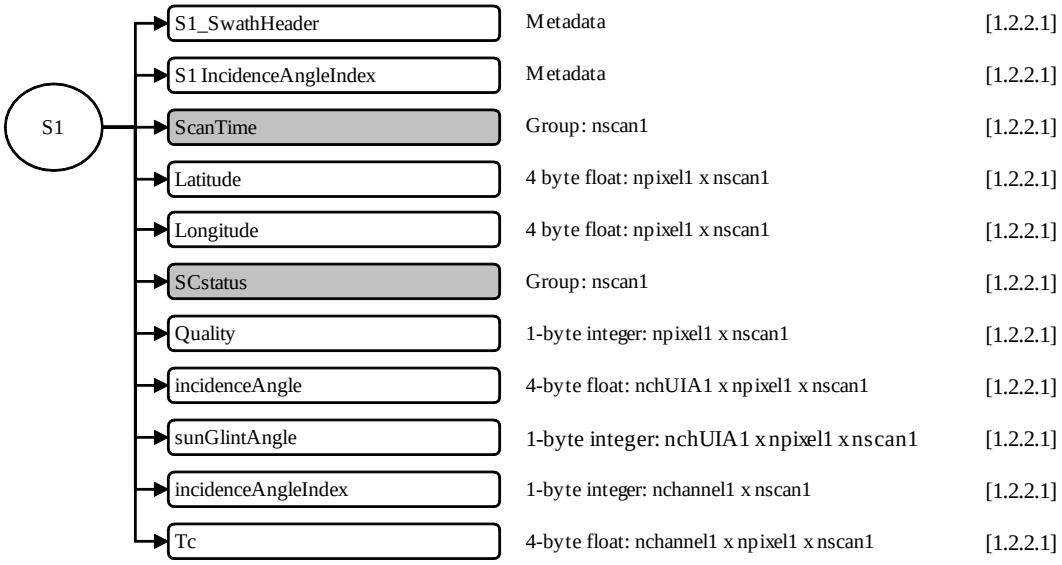

Figure 1.1-2 Data Format Structure for 1CGMI, S1

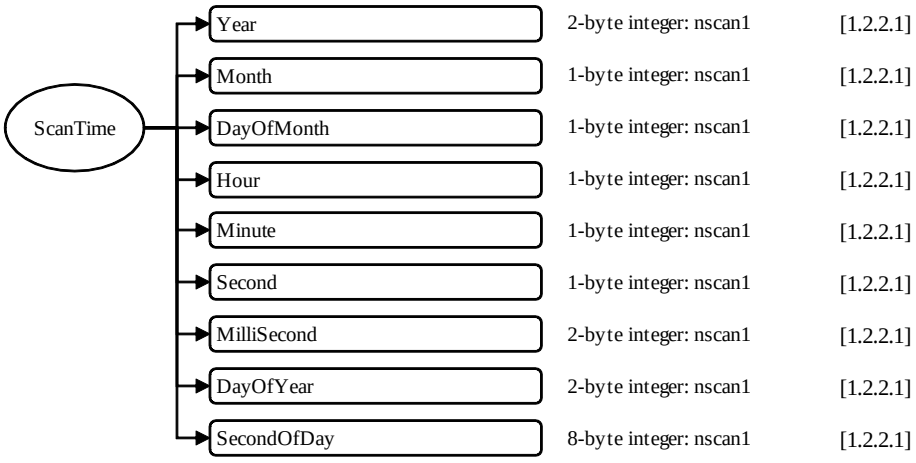

Figure 1.1-3 Data Format Structure for 1CGMI, S1, ScanTime

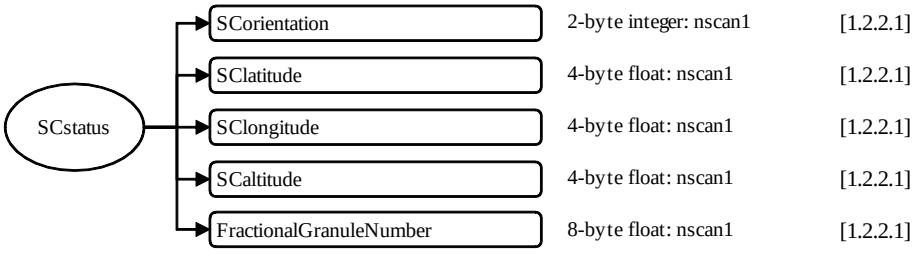

Figure 1.1-4 Data Format Structure for 1CGMI, S1, SCstatus

1.1.3.2 Data Format Structure for S2 Group

S2 Group's structure is shown in this section.

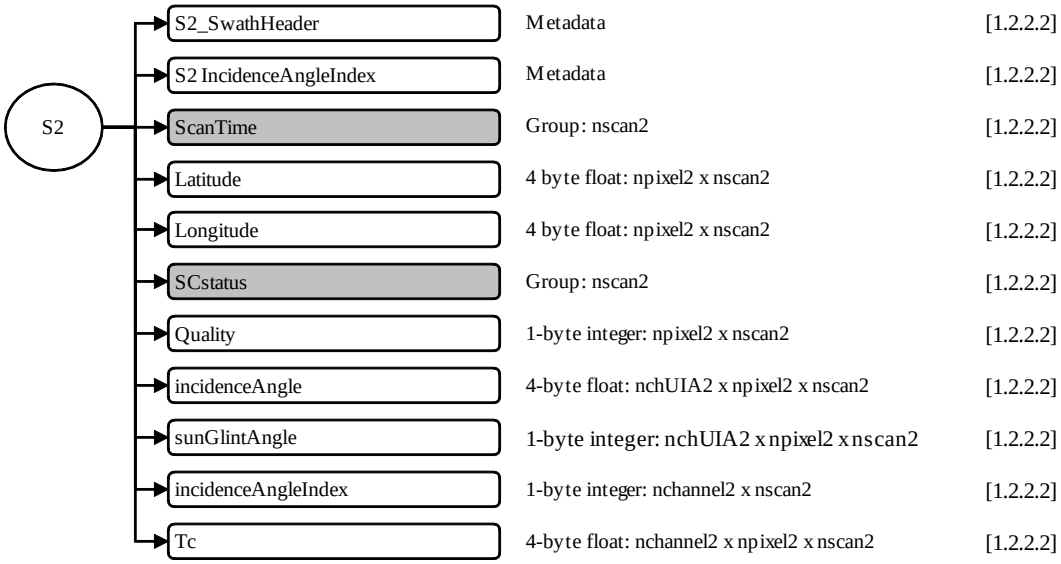

Figure 1.1-5 Data Format Structure for 1CGMI, S2

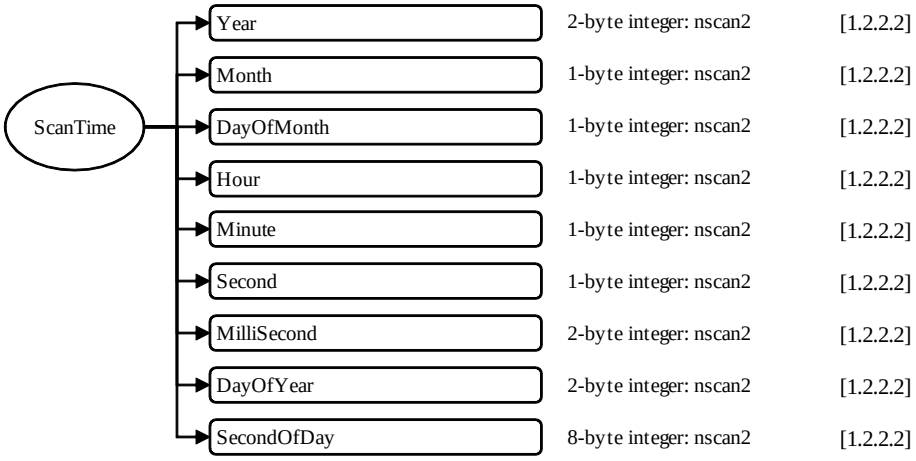

Figure 1.1-6 Data Format Structure for 1CGMI, S2, ScanTime

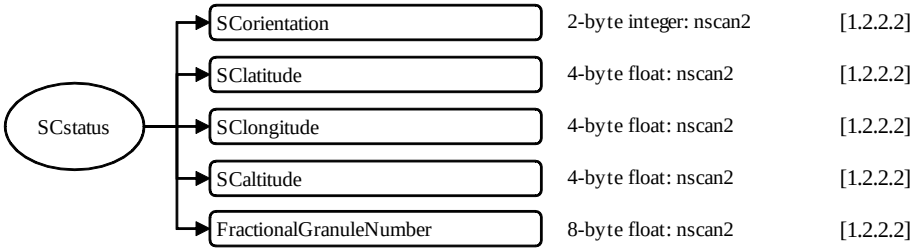

Figure 1.1-7 Data Format Structure for 1CGMI, S2, SCstatus

1.2. Contents of objects in each Group

1.2.1. Metadata

1.2.1.1 FileHeader

FileHeader contains metadata of general interest. Table 1.2-1 shows each metadata elements in FileHeader.

Table 1.2-1 FileHeader Group

Metadata Element	Estimated Size (bytes)	Description
DOI	256	Digital Object Identifier *Value is blank currently
DOIauthority	256	Digital Object Identifier Authority.
DOIshortName	256	Digital Object Identifier Short Name. *Value is blank currently.
AlgorithmID	50	The algorithm that generated this product, e.g., 2A12.
AlgorithmVersion	50	The version of the algorithm that generated this product.
FileName	50	The file name of this granule.
SatelliteName	10	Values are: TRMM GPM MULTI F10 ... F18 AQUA GCOMW1 CORIOLIS MT1 NOAA15 ... NOAA19 METOPANPP. More values will be added as they are known.
InstrumentName	10	Values are: PR TMI VIRS PRTMI KU KA DPR GMI DPRGMI MERGED SSMI SSMIS AMSRE AMSR2 WIND-SAT MADRAS AMSUA AMSUB SAPHIR MHS ATMS. More values will be added as they are known.
GenerationDateTime	50	The date and time this granule was generated. The format is YYYY-MM-DDTHH:MM:SS.sssZ, where YYYY is 4-digit year, MM is month number, DD is day of month, T is ”T”, HH is hour, MM is minute, SS is second, sss is millisecond, and Z is ”Z”. All fields are zero-filled. The missing value is constructed by replacing all digits with 9, i.e., 9999-99-99T99:99:99.999Z
StartGranuleDateTime	50	The start time defining this granule. The format is the same as GenerationDateTime. DETAILS: An orbital granule starts when the satellite is at the position defined by GranuleStart. Thus the start time is not the first scan time. Some algorithms have overlap scans in the file before the start time as defined in SwathHeader. A monthly granule starts on the first ms of the month, for example March 1998 would be 1998-03-01T00:00:00.000Z
StopGranuleDateTime	50	The stop time defining this granule. The format is the same as GenerationDateTime. DETAILS: An orbital granule stops when the satellite is at the position defined by GranuleStart. Thus the stop time is not the last scan time. Some algorithms have overlap scans in the file after the stop time as defined in SwathHeader. A monthly granule stops on the last ms of the month, for example March 1998 would be 1998-03-31T23:59:59.999Z
GranuleNumber	50	The number of this granule, which starts as in GranuleStart. If the GranuleStart is identical to the orbit start, then the GranuleNumber will be the same as the orbit number. The GranuleNumber will have 6 digits, including leading zeroes, for example 001234.
NumberOfSwaths	50	The number of swaths in this granule.
NumberOfGrids	50	The number of grid structures in this granule.
GranuleStart	50	The starting place in the orbit of this granule. Currently defined values are ”SOUTHERNMOST LATITUDE” and ”NORTHBOUND EQUATOR CROSSING”.
TimeInterval	50	The time interval covered by this granule. Values are ”ORBIT”, ”HALF ORBIT”, ”HALF HOUR”, ”HOUR”, ”3 HOUR”, ”DAY”, ”MONTH”, ”CONTACT”.

Metadata Element	Estimated Size (bytes)	Description
ProcessingSystem	50	The name of the processing system, e.g., ”PPS”, ”JAXA”.
ProductVersion	50	The data version assigned by the processing system.
EmptyGranule	50	Whether a granule is empty. Values are ”EMPTY” or ”NOT EMPTY”.
MissingData	50	The number of missing scans.

1.2.1.2 InputRecord

InputRecord contains a record of input files for this granule. Table 1.2-2 shows each metadata elements in InputRecord.

Table 1.2-2 InputRecord Group

Metadata Element	Estimated Size (bytes)	Description
InputFileName	1000	A list of input file names for this granule.
InputAlgorithmVersions	1000	A list of algorithm versions of the input files for this granule.
InputGenerationDatteTimes	1000	A list of generation date times of the input files for this granule. The format is the same as GenerationDateTime.

1.2.1.3 NavigationRecord

NavigationRecord contains navigation metadata for this granule. Table 1.2-3 shows each metadata elements in NavigationRecord.

Table 1.2-3 NavigationRecord Group

Metadata Element	Estimated Size (bytes)	Description
LongitudeOnEquator	50	The longitude where the satellite crosses the equator going from south to north.
UTCDateTimeOnEquator	50	The UTC time when the satellite crosses the equator going from south to north. The format is the same as GenerationDate Time.
MeanSolarBetaAngle	50	The average solar beta angle in this granule.
EphemerisFileName	50	Name of the ephemeris file input for processing.
AttitudeFileName	50	Name of the attitude file input for processing.
GeoControlFileName	50	Name of the GeoTK Control Parameters File input for processing.
EphemerisSource	50	Values are ”0 CONSTANT INPUT TEST VALUE”, ”1 GROUND ESTIMATED STATE (GES)”, ”2 GPS FILTERED SOLUTION (GEONS)”, ”3 GPS POINT SOLUTION (PVT)”, ”4 ON BOARD PROPAGATED (OBP)”, ”5 OEM GROUND EPHEMERIS FILE”, ”6 GEONS WITH FALLBACK AS FLAGGED”, ”7 PVT WITH FALLBACK AS FLAGGED”, ”8 OBP WITH FALLBACK AS FLAGGED”, ”9 GES WITH FALLBACK AS FLAGGED”
AttitudeSource	50	Values are ”0 CONSTANT INPUTS FOR TESTING”, ”1 ON BOARD CALCULATED PITCH ROLL YAW”
GeoToolkitVersion	50	Version of the GeoToolkit
SensorAlignmentFirstRotationAngle	50	Alignment angle, first rotation, in degrees. Rotation adjustment from sensor coordinates to the Attitude Control System Flight Coordinates.
SensorAlignmentSecondRotationAngle	50	Alignment angle, second rotation, in degrees.
SensorAlignmentThirdRotationAngle	50	Alignment angle, third rotation, in degrees.

Metadata Element	Estimated Size (bytes)	Description
SensorAlignmentFirstRotationAxis	50	Euler rotation sequence, first rotation axis. Values are ”1”, ”2”, ”3” (representing X, Y, Z).
SensorAlignmentSecondRotationAxis	50	Euler rotation sequence, second rotation axis. Values are ”1”, ”2”, ”3” (representing X, Y, Z).
SensorAlignmentThirdRotationAxis	50	Euler rotation sequence, third rotation axis. Values are ”1”, ”2”, ”3” (representing X, Y, Z).

1.2.1.4 FileInfo

FileInfo contains metadata used by the PPS I/O Toolkit. Table 1.2-4 shows each metadata elements in FileInfo.

Table 1.2-4 FileInfo Group

Metadata Element	Estimated Size (bytes)	Description
DataFormatVersion	50	The version of the data format used to write this file. This version is separate for each AlgorithmID. The order is: ”a” ”b” ... ”z” ”aa” ”ab” ... ”az” ”ba” ”bb” ...
TKCodeBuildVersion	50	Usually TK CodeBuildVersion is ”1”. If the I/O routines built by TKIO change even though the DataFormatVersion is unchanged, then TK CodeBuildVersion increments to ”2”, ”3”, ... If subsequently DataFormatVersion changes, TKCodeBuildVersion becomes ”1” again.
MetadataVersion	50	The version of metadata used to write this file. This version is separate for each AlgorithmID. The order is: ”a” ”b” ... ”z” ”aa” ”ab” ... ”az” ”ba” ”bb” ...
FormatPackage	50	The underlying format of this granule. Values are ”HDF4”, ”HDF5”, ”NETCDF”, ”TKBINARY”
BlueprintFilename	50	The filename of the primary blueprint file that defined the format used to write this file.
BlueprintVersion	10	The BlueprintVersion of the format definition
TKIOVersion	50	The version of TKIO used to create I/O routines to write this file. TKIOVersion does not define the format used to write this file.
MetadataStyle	50	The style in which the metadata was written, e.g., ”PVL”. ”PVL” means < parameter >=< value >;
EndianType	50	The endian type of the system that wrote this file. Values are ”BIG ENDIAN” and ”LITTLE ENDIAN”.

1.2.1.5 XCALinfo

XCALinfo contains metadata required by 1C intercalibrated files.

Table 1.2-5 XCALinfo Group

Metadata Element	Estimated Size (bytes)	Description
CalibrationStandard	50	The brightness temperature reference standard, e.g., ”cc 1.1”.
CalibrationTable	50	The name of a file containing the calibration table used to make this product, e.g., ”1C.AQUA.ASMRE.XCAL2013-P.tbl”.
CalibrationLevel	50	The level development of the intercalibration for a given sensor. When this level increases for a given sensor the Level 1C files are reprocessed and the version number will also increment. The intercalibration level is defined as follows: N (None): No intercalibration has been applied. Tbs are unchanged from Level 1B source files.

Metadata Element	Estimated Size (bytes)	Description
		P (Preliminary): A preliminary or beta intercalibration has been applied to match the Tb to the reference. V (Verified): The intercalibration has been verified by at least one independent effort. C (Consensus): The XCAL intercalibration has been finalized and accepted by the Science Team.

1.2.2. Data Group

Elements of data group are explained in detail in this section.

1.2.2.1 S1 (Swath)

(1) S1_SwathHeader (Metadata)

S1_SwathHeader contains metadata for swaths.

Table 1.2-6 S1_SwathHeader Group

Metadata Element	Estimated Size (bytes)	Description
NumberScansInSet	50	The scans read by TKreadScan are a ”set”. For single swath data, one scan is read so NumberScansInSet=1. For multiple swath data, one TKreadScan may read more than one scan. For example, for SSM/I data one TKreadScan reads one low frequency scan and two high frequency scans. Therefore NumberScansInSet=1 for the low frequency swath and NumberScansInSet=2 for the high frequency swath.
MaximumNumberScansTotal	50	The maximum allowed number of total scans in this swath. Total scans = overlap scans before granule + scans in granule + overlap scans after granule.
NumberScansBeforeGranule	50	The number of overlap scans before the first scan of the granule in this swath.
NumberScansGranule	50	The number of scans in the granule in this swath.
NumberScansAfterGranule	50	The number of overlap scans after the last scan of the granule in this swath.
NumberPixels	50	The number of IFOV in each scan in this swath.
ScanType	50	The type of scan in this swath. Values are: ”CROSSTRACK” and ”CONICAL”

(2) S1_IncidenceAngleIndex (Metadata)

S1_IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array. See the description of the data array incidenceAngleIndex for details.

(3) ScanTime (Group in S1)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan1)

4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:

-9999 Missing value

Month (1-byte integer, array size: nscan1)

Month of the year. Values range from 1 to 12 months. Special values are defined as:

-99 Missing value

DayOfMonth (1-byte integer, array size: nscan1)

Day of the month. Values range from 1 to 31 days. Special values are defined as:

-99 Missing value

Hour (1-byte integer, array size: nscan1)

UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:

-99 Missing value

Minute (1-byte integer, array size: nscan1)

Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:

-99 Missing value

Second (1-byte integer, array size: nscan1)

Second of the minute. Values range from 0 to 60 s. Special values are defined as:

-99 Missing value

MilliSecond (2-byte integer, array size: nscan1)

Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:

-9999 Missing value

DayOfYear (2-byte integer, array size: nscan1)

Day of the year. Values range from 1 to 366 days. Special values are defined as:

-9999 Missing value

SecondOfDay (8-byte float, array size: nscan1)

A time associated with the scan. scanTime sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:

-9999.9 Missing value

Table 1.2-7 ScanTime Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Year	-9999	1950	2100	[year]	2-byte int	2 x nscan1	2	nscan1	1	1
2	Month	-99	1	12	[month]	1-byte integer	1 x nscan1	1	nscan1	1	1
3	DayOFMonth	-99	1	31	[day]	1-byte integer	1 x nscan1	1	nscan1	1	1
4	Hour	-99	0	23	[hour]	1-byte integer	1 x nscan1	1	nscan1	1	1
5	Minute	-99	0	59	[minute]	1-byte integer	1 x nscan1	1	nscan1	1	1
6	Second	-99	0	60	[s]	1-byte integer	1 x nscan1	1	nscan1	1	1
7	MilliSecond	-9999	0	999	[ms]	2-byte int	2 x nscan1	2	nscan1	1	1
8	DayOfYear	-9999	1	366	[day]	2-byte int	2 x nscan1	2	nscan1	1	1
9	SecoundOfDay	-9999.9	0	86400	[s]	8-byte float	8 x nscan1	8	nscan1	1	1

(4) Latitude (4-byte float, array size: npixel1 x nscan1)

The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:

-9999.9 Missing value

Table 1.2-8 Latitude Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Latitude	-9999.9	-90	90	[degree]	4-byte float	4 x 221 x nscan1	4	npixel1	nscan1	1

(5) Longitude (4-byte float, array size: npixel1 x nscan)

The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:

-9999.9 Missing value

Table 1.2-9 Longitude Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Longitude	-9999.9	-180	180	[degree]	4-byte float	4 x 221 x nscan1	4	npixel1	nscan1	1

(6) SCStatus (Group in S1)

SCorientation (2-byte integer, array size: nscan1)

The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:

-9999 Missing value

SClatitude (4-byte float, array size: nscan1)

Values range from -90 to 90 degrees. Special values are defined as:

-9999.9 Missing value

SClongitude (4-byte float, array size: nscan1)

Values range from -180 to 180 degrees. Special values are defined as:

-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan1)

Values range from 0 to 1000 km. Special values are defined as:

-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan1)

The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:

-9999.9 Missing value

Table 1.2-10 SCStatus Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	SCorientation	-9999	0	360	[degree]	2-byte integer	2 x ncan1	2	nscan1	1	1
2	SClatitude	-9999.9	-90	90	[degree]	4-byte float	4 x ncan1	4	nscan1	1	1
3	SClongitude	-9999.9	-180	180	[degree]	4-byte float	4 x ncan1	4	nscan1	1	1
4	SCaltitude	-9999.9	0	1000	[km]	4-byte float	4 x ncan1	4	nscan1	1	1
5	FranctionalGranleNumber	-9999.9	0	100000		8-byte float	8 x ncan1	8	nscan1	1	1

(7) Quality (1-byte integer, array size: npixel1 x nscan1)

Quality of Tc in the swath.

GENERAL SPECIFICATIONS

0 = Good data in all channels in the swath

gt 0 = Cautionary warning flags

1 - 99 = Generic Flags (all sensors)

100 – 127 = Sensor specific flags

lt 0 = Major errors resulting in missing data

-(1-98) = Generic flags (all sensors)

-99 = Missing value (no quality information available)

-(100-127) = Sensor specific flags

DETAILED SPECIFICATIONS

0 = Good data

1 = Possible sun glint

2 = Possible radio frequency interference

3 = Degraded geolocation data

4 = Data corrected for warm load intrusion

100 = Scan blanking on

-1 = Data is missing from file or unreadable

-2 = Unphysical brightness temperature (Tb lt 50K or 350K gt Tb)

-3 = Error in geolocation data

-4 = Data missing in one channel

-5 = Data missing in multiple channels

-6 = Lat/lon values are out of range

-7 = Non-normal status modes

-10 = Distance to corresponding LF pixel > 7 km
(Used in L1C-R Product only)

-99 = Missing value (no quality information available)

Table 1.2-11 Quality Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Quality	-99	-	-	-	1-byte int	1 x 221 x nscan1	1	npixel1	nscan1	1

(8) incidenceAngle (4-byte float, array size: nchUIA1 x npixel1 x nscan1)

Earth incidence angle. Values range from 0 to 90 degrees. Special values are defined as:

-9999.9 Missing value

Table 1.2-12 incidenceAngle Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	incidenceAngle	-9999.9	0	90	[degree]	4-byte float	4 x 1 x 221 x nscan1	4	nchUIA1	npixel1	nscan1

(9) sunGlintAngle (1-byte integer, array size: nchUIA1 x npixel1 x nscan1)

Sun glint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees.

Sun below horizon value is -88.

-99 Missing value

Table 1.2-13 sunGlintAngle Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	sunGlintAngle	-99	0	127	[degree]	1-byte int	1 x 1 x 221 x nscan1	1	nchUIA1	npixel1	nscan1

(10) incidenceAngleIndex (1-byte integer, array size: nchannel1 x nscan1)

Values range from 0 to 100. Special values are defined as:

-99 Missing value

Table 1.2-14 incidenceSngleIndex Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	incidenceAngleIndex	-99	0	100	-	1-byte int	1 x 9 x nscan1	1	nchannel1	nscan1	1

(11) Tc (4-byte float, array size: nchannel1 x npixel1 x nscan1)

GPM Common Calibrated Brightness Temperature. The Channels are:

10.7 GHz vertically-polarized TBs
10.7 GHz horizontally-polarized TBs
18.7 GHz vertically-polarized TBs
18.7 GHz horizontally-polarized TBs
23.8 GHz vertically-polarized TBs
36.5 GHz vertically-polarized TBs
36.5 GHz horizontally-polarized TBs
89.0 GHz vertically-polarized TBs
89.0 GHz horizontally-polarized TBs

Values range from 0 to 10000 K. Special values are defined as:

-9999.9 Missing value

Table 1.2-15 Tc Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Tc	-9999.9	0	10000	[K]	4-byte float	4 x 9 x 221 x nscan1	4	nchannel1	npixel1	nscan1

1.2.2.2 S2 (Swath)

(1) S2_SwathHeader (Metadata)

S2_SwathHeader contains metadata for swaths.

Table 1.2-16 S2_SwathHeader Group

Metadata Element	Estimated Size (bytes)	Description
NumberScansInSet	50	The scans read by TKreadScan are a ”set”. For single swath data, one scan is read so NumberScansInSet=1. For multiple swath data, one TKreadScan may read more than one scan. For example, for SSM/I data one TKreadScan reads one low frequency scan and two high frequency scans. Therefore NumberScansInSet=1 for the low frequency swath and NumberScansInSet=2 for the high frequency swath.
MaximumNumberScansTotal	50	The maximum allowed number of total scans in this swath. Total scans = overlap scans before granule + scans in granule + overlap scans after granule.
NumberScansBeforeGranule	50	The number of overlap scans before the first scan of the granule in this swath.
NumberScansGranule	50	The number of scans in the granule in this swath.
NumberScansAfterGranule	50	The number of overlap scans after the last scan of the granule in this swath.
NumberPixels	50	The number of IFOV in each scan in this swath.
ScanType	50	The type of scan in this swath. Values are: ”CROSSTRACK” and ”CONICAL”

(2) S2_IncidenceAngleIndex (Metadata)

S2_IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array. See the description of the data array incidenceAngleIndex for details.

(3) ScanTime (Group in S2)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan2)

4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:

-9999 Missing value

Month (1-byte integer, array size: nscan2)

Month of the year. Values range from 1 to 12 months. Special values are defined as:

-99 Missing value

DayOfMonth (1-byte integer, array size: nscan2)

Day of the month. Values range from 1 to 31 days. Special values are defined as:

-99 Missing value

Hour (1-byte integer, array size: nscan2)

UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:

-99 Missing value

Minute (1-byte integer, array size: nscan2)

Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:

-99 Missing value

Second (1-byte integer, array size: nscan2)

Second of the minute. Values range from 0 to 60 s. Special values are defined as:

-99 Missing value

MilliSecond (2-byte integer, array size: nscan2)

Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:

-9999 Missing value

DayOfYear (2-byte integer, array size: nscan2)

Day of the year. Values range from 1 to 366 days. Special values are defined as:

-9999 Missing value

SecondOfDay (8-byte float, array size: nscan2)

A time associated with the scan. scanTime sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:

-9999.9 Missing value

Table 1.2-17 ScanTime Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Year	-9999	1950	2100	[year]	2-byte integer	2 x nscan2	2	nscan2	1	1
2	Month	-99	1	12	[month]	1-byte int	1 x nscan2	1	nscan2	1	1
3	DayOFMonth	-99	1	31	[day]	1-byte int	1 x nscan2	1	nscan2	1	1
4	Hour	-99	0	23	[hour]	1-byte int	1 x nscan2	1	nscan2	1	1
5	Minute	-99	0	59	[minute]	1-byte int	1 x nscan2	1	nscan2	1	1
6	Second	-99	0	60	[s]	1-byte int	1 x nscan2	1	nscan2	1	1
7	MilliSecond	-9999	0	999	[ms]	2-byte integer	2 x nscan2	2	nscan2	1	1
8	DayOfYear	-9999	1	366	[day]	2-byte integer	2 x nscan2	2	nscan2	1	1
9	SecoundOfDay	-9999.9	0	86400	[s]	8-byte float	8 x nscan2	8	nscan2	1	1

(4) Latitude(4-byte float, array size: npixel2 x nscan2)

The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:

-9999.9 Missing value

Table 1.2-18 Latitude Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Latitude	-9999.9	-90	90	[degree]	4-byte float	4 x 221 x nscan2	4	npixel2	nscan2	1

(5) Longitude (4-byte float, array size: npixel2 x nscan2)

The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:

-9999.9 Missing value

Table 1.2-19 Longitude Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Longitude	-9999.9	-180	180	[degree]	4-byte float	4 x 221 x nscan2	4	npixel2	nscan2	1

(6) SCStatus (Group in S2)

SCorientation (2-byte integer, array size: nscan2)

The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:

-9999 Missing value

SClatitude (4-byte float, array size: nscan2)

Values range from -90 to 90 degrees. Special values are defined as:

-9999.9 Missing value

SClongitude (4-byte float, array size: nscan2)

Values range from -180 to 180 degrees. Special values are defined as:

-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan2)

Values range from 0 to 1000 km. Special values are defined as:

-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan2)

The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:

-9999.9 Missing value

Table 1.2-20 SCStatus Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	SCorientation	-9999	0	360	[degree]	2-byte integer	2 x nscan2	2	nscan2	1	1
2	SClatitude	-9999.9	-90	90	[degree]	4-byte float	4 x nscan2	4	nscan2	1	1
3	SClongitude	-9999.9	-180	180	[degree]	4-byte float	4 x nscan2	4	nscan2	1	1
4	SCaltitude	-9999.9	0	1000	[km]	4-byte float	4 x nscan2	4	nscan2	1	1
5	FranctionalGranleNumber	-9999.9	0	100000		8-byte float	8 x nscan2	8	nscan2	1	1

(7) Quality (1-byte integer, array size: npixel2 x nscan2)

Quality of Tc in the swath.

GENERAL SPECIFICATIONS

0 = Good data in all channels in the swath

gt 0 = Cautionary warning flags

1 - 99 = Generic Flags (all sensors)

100 – 127 = Sensor specific flags

lt 0 = Major errors resulting in missing data

-(1-98) = Generic flags (all sensors)

-99 = Missing value (no quality information available)

-(100-127) = Sensor specific flags

DETAILED SPECIFICATIONS

0 = Good data
1 = Possible sun glint
2 = Possible radio frequency interference
3 = Degraded geolocation data
4 = Data corrected for warm load intrusion
100 = Scan blanking on
-1 = Data is missing from file or unreadable
-2 = Unphysical brightness temperature (Tb lt 50K or 350K gt Tb)
-3 = Error in geolocation data
-4 = Data missing in one channel
-5 = Data missing in multiple channels
-6 = Lat/lon values are out of range
-7 = Non-normal status modes
-10 = Distance to corresponding LF pixel > 7 km
(Used in L1C-R Product only)
-99 = Missing value (no quality information available)

Table 1.2-21 Quality Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Quality	-99	-	-	-	1-byte int	1 x 221 x nscan2	1	npixel2	nscan2	1

(8) incidenceAngle (4-byte float, array size: nchUIA2 x npixel2 x nscan2)

Earth incidence angle. Values range from 0 to 90 degrees. Special values are defined as:

-9999.9 Missing value

Table 1.2-22 incidenceAngle Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	incidenceAngle	-9999.9	0	90	[degree]	4-byte float	4 x 1 x 221 x nscan2	4	nchUIA2	npixel2	nscan2

(9) sunGlintAngle (1-byte integer, array size: nchUIA2 x npixel2 x nscan2)

Sun glint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees.

Sun below horizon value is -88.

-99 Missing value

Table 1.2-23 sunGlintAngle Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	sunGlintAngle	-99	0	127	[degree]	1-byte int	4 x 1 x 221 x nscan2	1	nchUIA2	npixel2	nscan2

(10) incidenceAngleIndex (1-byte integer, array size: nchannel2 x nscan2)

Values range from 0 to 100. Special values are defined as:

-99 Missing value

Table 1.2-24 incidenceAngleIndex Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	incidenceAngleIndex	-99	0	100	-	1-byte int	1 x 4 x nscan2	1	nchannel2	nscan2	1

(11) Tc (4-byte float, array size: nchannel2 x npixel2 x nscan2)

GPM Common Calibrated Brightness Temperature. The Channels are:

166.0 GHz vertically-polarized TBs
166.0 GHz horizontally-polarized TBs
183.31+/-3 GHz vertically-polarized TBs
183.31+/-8 GHz vertically-polarized TBs

Values range from 0 to 400 K. Special values are defined as:

-9999.9 Missing value

Table 1.2-25 Tc Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Tc	-9999.9	0	10000	[K]	4-byte float	4 x 4 x 221 x nscan2	4	nchannel2	npixel2	nscan2

2. 1CTMI – GPM Common Calibrated Brightness Temperature

2.1. Data Format Structure

2.1.1. Dimension definition

Dimension definitions:

- nscan1
  - var Number of Swath S1 scans in the granule.
- nchannel1
  - 2 Number of Swath S1 channels (10V 10H).
- npixel1
  - 104 Number of Swath S1 pixels in one scan.
- nchUIA1
  - 2 Number of Swath S1 unique incidence angles.
- nscan2
  - var Number of Swath S2 scans in the granule.
- nchannel2
  - 5 Number of Swath S2 channels (19V 19H 21V 37V 37H)
- npixel2
  - 104 Number of Swath S2 pixels in one scan.
- nchUIA2
  - 1 Number of Swath S2 unique incidence angles.
- nscan3
  - var Number of Swath S3 scans in the granule.
- nchannel3
  - 2 Number of Swath S3 channels (85V 85H).
- npixel3
  - 208 Number of Swath S3 pixels in one scan.
- nchUIA3
  - 1 Number of Swath S3 unique incidence angles.

2.1.2. Data Format Structure for 1CTMI – GPM Common Calibrated Brightness Temperature

1CTMI contains common calibrated brightness temperatures from the TMI passive microwave instrument flown on the TRMM satellite. There are 3 swaths. Swath S1 has 2 low resolution channels (10V 10H). Swath S2 has 5 low resolution channels (19V 19H 21V 37V 37H). Swath S3 has 2 high resolution channels (85V 85H). Data for all swaths is observed in the same revolution of the instrument.

Earth observations are taken during a segment of the rotation when TMI is looking in the +x direction of the TRMM satellite. Since the spacecraft turns around every few weeks, +x may be forward or aft. We define the spacecraft axis v, used in the definition of the variable SCorientation, at the center of this segment and the same as the +x direction.

RELATION BETWEEN THE SWATHS: Swath S2 has the same number of scans and pixels as Swath S1. Swath S3 has the same number of scans but twice as many pixels as Swath S1. Each S1 and S2 scan contains low frequency channels sampled 104 times along the scan. Each S3 scan contains high frequency channels sampled 208 times along the scan. S1 S2 and S3 scans are repeated every 1.9s. Along an S1 scan every other center of an S3 pixel coincides with the center of an S1 pixel.

The Figure below shows the locations of the pixels of scans 1 and 2 for Swath 1 and Swath 3. Each ”+” represents centers of pixels from one or more swaths. For example, the label ” S1:1,2 S3:1,3” means that both Swath S1, Scan 1, Pixel 2 and Swath S3, Scan 1, Pixel 3 are located at the ”+”.

S1:1, 1 S3:1, 1	S3:1, 2	S1:1, 2 S3:1, 3		S1:1, 104 S3:1, 207	S3:1, 208
+	+	+	…..		+
S1:2, 1 S3:2, 1	S3:2, 2	S1:2, 2 S3:2, 3		S1:2, 104 S3:2, 207	S3:2, 208
+	+	+	…..	+	+

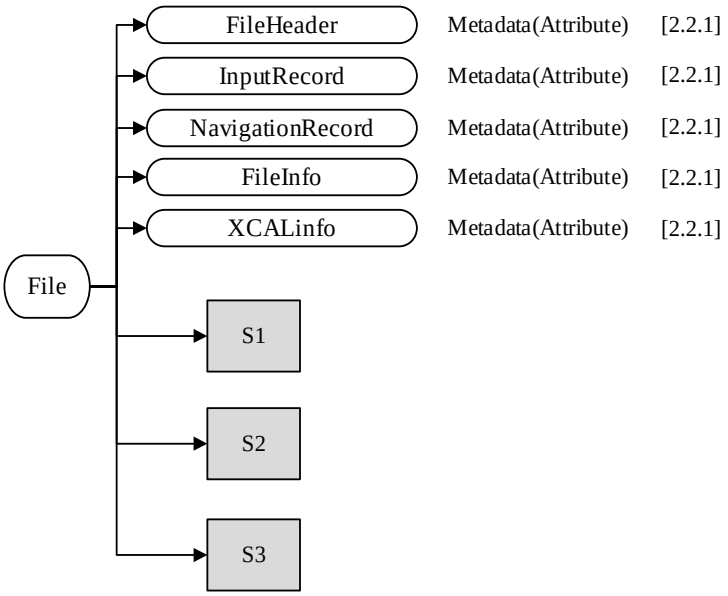

Figure 2.1-1 Data Format Structure for 1CTMI – GPM Common Calibrated Brightness Temperature

2.1.3. Data Format Structure for each Group

2.1.3.1 Data Format Structure for S1 Group

S1 Group's structure is shown in this section.

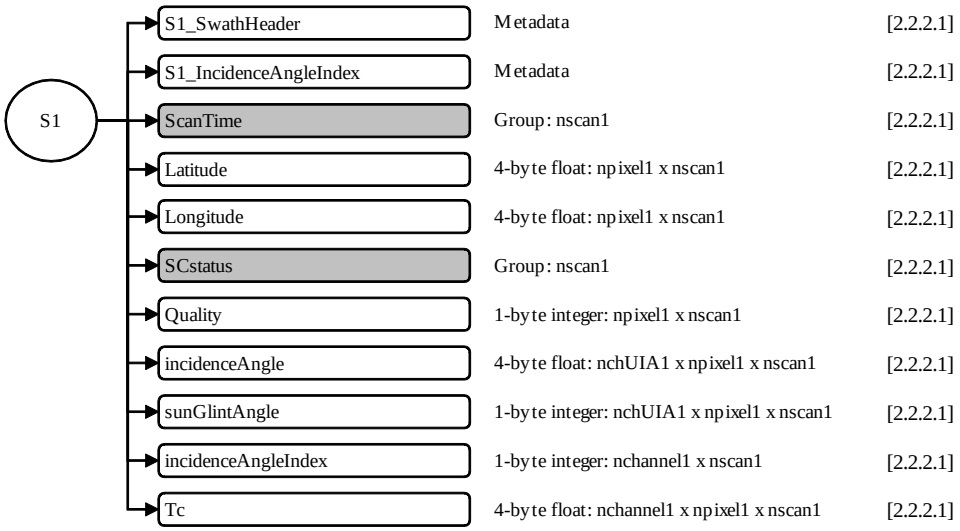

Figure 2.1-2 Data Format Structure for1CTMI, S1

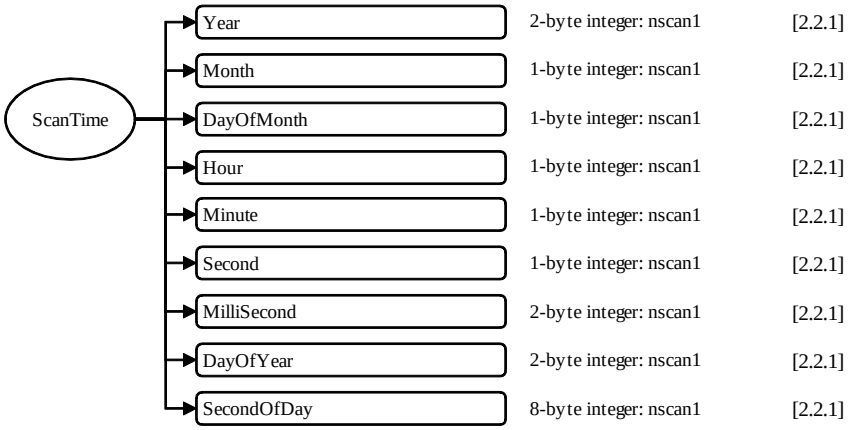

Figure 2.1-3 Data Format Structure for1CTMI, ScanTime

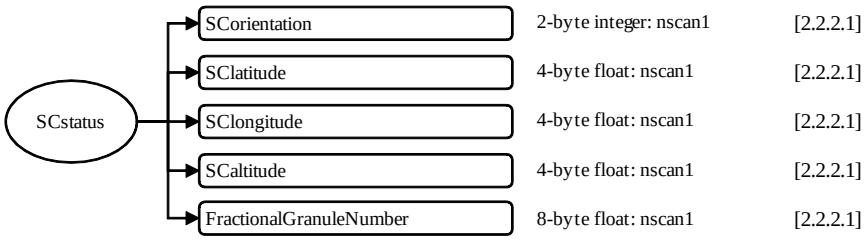

Figure 2.1-4 Data Format Structure for1CTMI, SCstatus

2.1.3.2 Data Format Structure for S2 Group

S2 Group's structure is shown in this section.

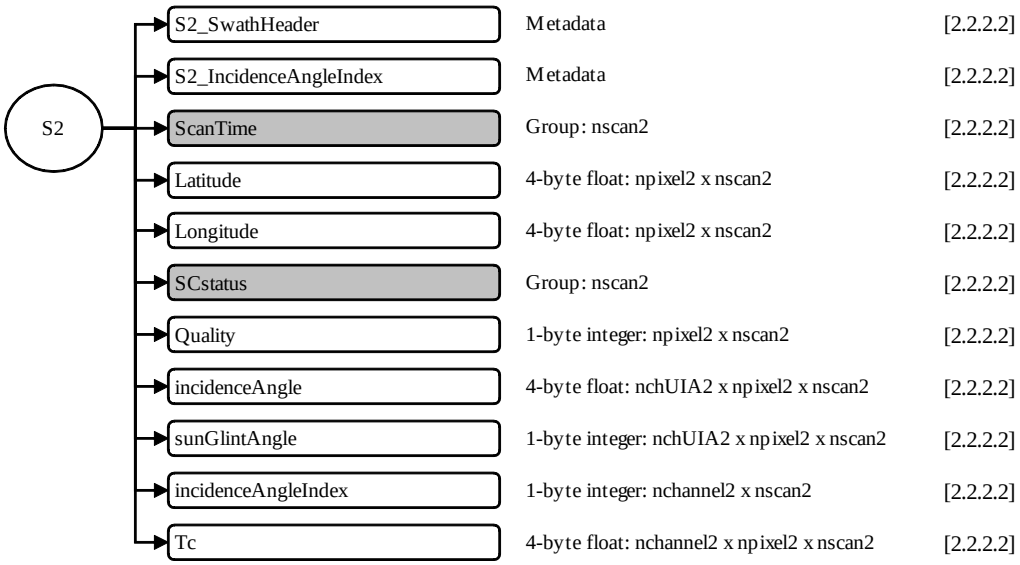

Figure 2.1-5 Data Format Structure for1CTMI, S2

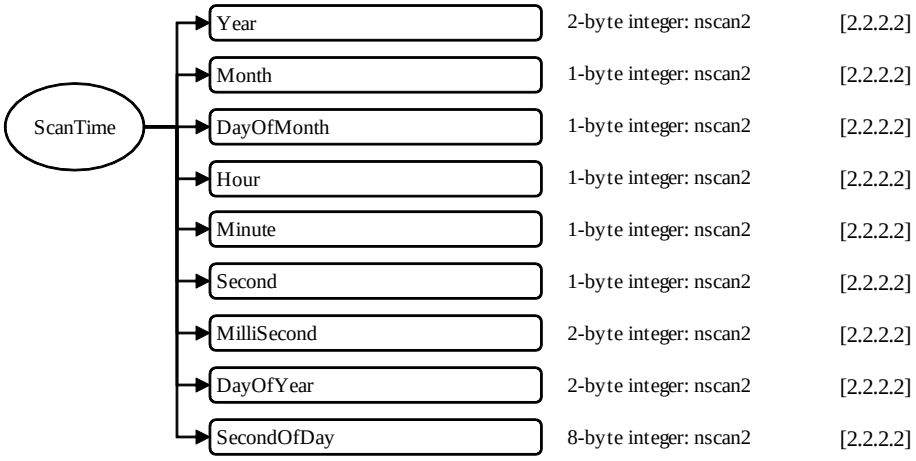

Figure 2.1-6 Data Format Structure for1CTMI, S2, ScanTime

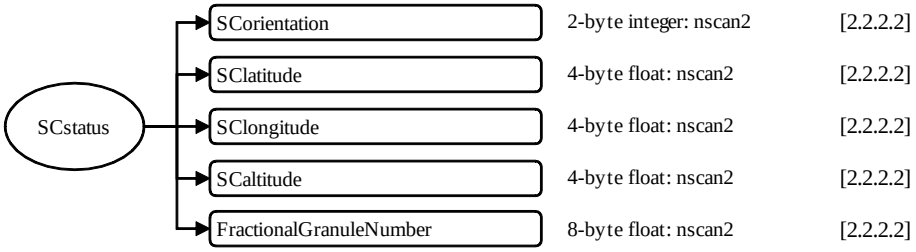

Figure 2.1-7 Data Format Structure for1CTMI, S2, SCstatus

2.1.3.3 Data Format Structure for S3 Group

S3 Group's structure is shown in this section.

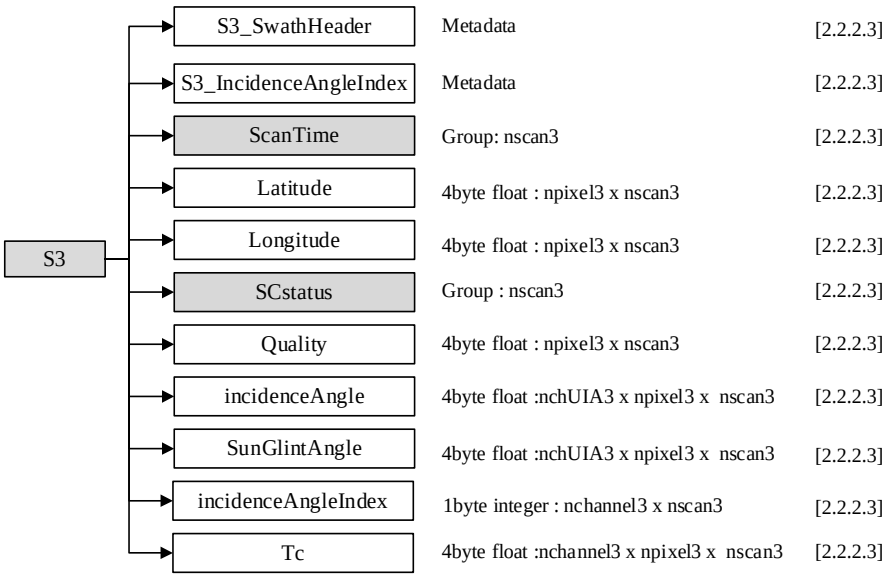

Figure 2.1-8 Data Format Structure for1CTMI, S3

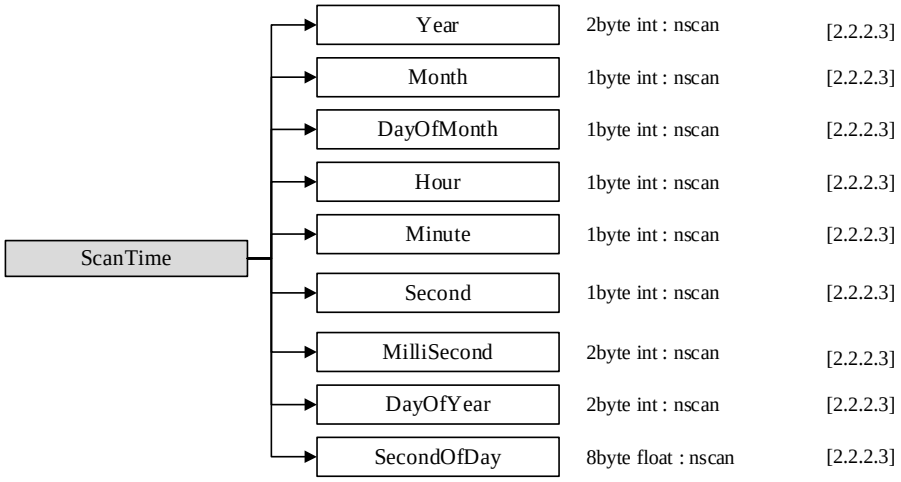

Figure 2.1-9 Data Format Structure for1CTMI, S3, ScanTime

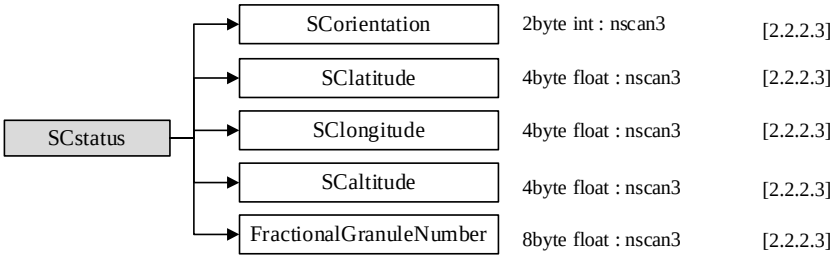

Figure 2.1-10 Data Format Structure for1CTMI, S3, SCstatus

2.2. Contents of objects in each Group

2.2.1. Metadata

2.2.1.1 FileHeader

FileHeader contains metadata of general interest. Table 2.2-1 shows each metadata elements in FileHeader.

Table 2.2-1 FileHeader Group

Metadata Element	Estimated Size (bytes)	Description
DOI	256	Digital Object Identifier *Value is blank currently
DOIauthority	256	Digital Object Identifier Authority.
DOIshortName	256	Digital Object Identifier Short Name. *Value is blank currently.
AlgorithmID	50	The algorithm that generated this product, e.g., 2A12.
AlgorithmVersion	50	The version of the algorithm that generated this product.
FileName	50	The file name of this granule.
SatelliteName	10	Values are: TRMM GPM MULTI F10 ... F18 AQUA GCOMW1 CORIOLIS MT1 NOAA15 ... NOAA19 METOPANPP. More values will be added as they are known.
InstrumentName	10	Values are: PR TMI VIRS PRTMI KU KA DPR GMI DPRGMI MERGED SSMI SSMIS AMSRE AMSR2 WIND-SAT MADRAS AMSUA AMSUB SAPHIR MHS ATMS. More values will be added as they are known.
GenerationDateTime	50	The date and time this granule was generated. The format is YYYY-MM-DDTHH:MM:SS.sssZ, where YYYY is 4-digit year, MM is month number, DD is day of month, T is ”T”, HH is hour, MM is minute, SS is second, sss is millisecond, and Z is ”Z”. All fields are zero-filled. The missing value is constructed by replacing all digits with 9, i.e., 9999-99-99T99:99:99.999Z
StartGranuleDateTime	50	The start time defining this granule. The format is the same as GenerationDateTime. DETAILS: An orbital granule starts when the satellite is at the position defined by GranuleStart. Thus the start time is not the first scan time. Some algorithms have overlap scans in the file before the start time as defined in SwathHeader. A monthly granule starts on the first ms of the month, for example March 1998 would be 1998-03-01T00:00:00.000Z
StopGranuleDateTime	50	The stop time defining this granule. The format is the same as GenerationDateTime. DETAILS: An orbital granule stops when the satellite is at the position defined by GranuleStart. Thus the stop time is not the last scan time. Some algorithms have overlap scans in the file after the stop time as defined in SwathHeader. A monthly granule stops on the last ms of the month, for example March 1998 would be 1998-03-31T23:59:59.999Z
GranuleNumber	50	The number of this granule, which starts as in GranuleStart. If the GranuleStart is identical to the orbit start, then the GranuleNumber will be the same as the orbit number. The GranuleNumber will have 6 digits, including leading zeroes, for example 001234.
NumberOfSwaths	50	The number of swaths in this granule.
NumberOfGrids	50	The number of grid structures in this granule.
GranuleStart	50	The starting place in the orbit of this granule. Currently defined values are ”SOUTHERNMOST LATITUDE” and ”NORTHBOUND EQUATOR CROSSING”.
TimeInterval	50	The time interval covered by this granule. Values are ”ORBIT”, ”HALF ORBIT”, ”HALF HOUR”, ”HOUR”, ”3 HOUR”, ”DAY”, ”MONTH”, ”CONTACT”.

Metadata Element	Estimated Size (bytes)	Description
ProcessingSystem	50	The name of the processing system, e.g., ”PPS”, ”JAXA”.
ProductVersion	50	The data version assigned by the processing system.
EmptyGranule	50	Whether a granule is empty. Values are ”EMPTY” or ”NOT EMPTY”.
MissingData	50	The number of missing scans.

2.2.1.2 InputRecord

InputRecord contains a record of input files for this granule. Table 2.2-2 shows each metadata elements in InputRecord.

Table 2.2-2 InputRecord Group

Metadata Element	Estimated Size (bytes)	Description
InputFileName	1000	A list of input file names for this granule.
InputAlgorithmVersions	1000	A list of algorithm versions of the input files for this granule.
InputGenerationDatteTimes	1000	A list of generation date times of the input files for this granule. The format is the same as GenerationDateTime.

2.2.1.3 NavigationRecord

NavigationRecord contains navigation metadata for this granule. Table 2.2-3 shows each metadata elements in NavigationRecord.

Table 2.2-3 NavigationRecord Group

Metadata Element	Estimated Size (bytes)	Description
LongitudeOnEquator	50	The longitude where the satellite crosses the equator going from south to north.
UTCDateTimeOnEquator	50	The UTC time when the satellite crosses the equator going from south to north. The format is the same as GenerationDate Time.
MeanSolarBetaAngle	50	The average solar beta angle in this granule.
EphemerisFileName	50	Name of the ephemeris file input for processing.
AttitudeFileName	50	Name of the attitude file input for processing.
GeoControlFileName	50	Name of the GeoTK Control Parameters File input for processing.
EphemerisSource	50	Values are ”0 CONSTANT INPUT TEST VALUE”, ”1 GROUND ESTIMATED STATE (GES)”, ”2 GPS FILTERED SOLUTION (GEONS)”, ”3 GPS POINT SOLUTION (PVT)”, ”4 ON BOARD PROPAGATED (OBP)”, ”5 OEM GROUND EPHEMERIS FILE”, ”6 GEONS WITH FALLBACK AS FLAGGED”, ”7 PVT WITH FALLBACK AS FLAGGED”, ”8 OBP WITH FALLBACK AS FLAGGED”, ”9 GES WITH FALLBACK AS FLAGGED”
AttitudeSource	50	Values are ”0 CONSTANT INPUTS FOR TESTING”, ”1 ON BOARD CALCULATED PITCH ROLL YAW”
GeoToolkitVersion	50	Version of the GeoToolkit
SensorAlignmentFirstRotationAngle	50	Alignment angle, first rotation, in degrees. Rotation adjustment from sensor coordinates to the Attitude Control System Flight Coordinates.
SensorAlignmentSecondRotationAngle	50	Alignment angle, second rotation, in degrees.
SensorAlignmentThirdRotationAngle	50	Alignment angle, third rotation, in degrees.

Metadata Element	Estimated Size (bytes)	Description
SensorAlignmentFirstRotationAxis	50	Euler rotation sequence, first rotation axis. Values are ”1”, ”2”, ”3” (representing X, Y, Z).
SensorAlignmentSecondRotationAxis	50	Euler rotation sequence, second rotation axis. Values are ”1”, ”2”, ”3” (representing X, Y, Z).
SensorAlignmentThirdRotationAxis	50	Euler rotation sequence, third rotation axis. Values are ”1”, ”2”, ”3” (rep8resenting X, Y, Z).

2.2.1.4 FileInfo

FileInfo contains metadata used by the PPS I/O Toolkit. Table 2.2-4 shows each metadata elements in FileInfo.

Table 2.2-4 FileInfo Group

Metadata Element	Estimated Size (bytes)	Description
DataFormatVersion	50	The version of the data format used to write this file. This version is separate for each AlgorithmID. The order is: ”a” ”b” ... ”z” ”aa” ”ab” ... ”az” ”ba” ”bb” ...
TKCodeBuildVersion	50	Usually TK CodeBuildVersion is ”1”. If the I/O routines built by TKIO change even though the DataFormatVersion is unchanged, then TK CodeBuildVersion increments to ”2”, ”3”, ... If subsequently DataFormatVersion changes, TKCodeBuildVersion becomes ”1” again.
MetadataVersion	50	The version of metadata used to write this file. This version is separate for each AlgorithmID. The order is: ”a” ”b” ... ”z” ”aa” ”ab” ... ”az” ”ba” ”bb” ...
FormatPackage	50	The underlying format of this granule. Values are ”HDF4”, ”HDF5”, ”NETCDF”, ”TKBINARY”
BlueprintFilename	50	The filename of the primary blueprint file that defined the format used to write this file.
BlueprintVersion	10	The BlueprintVersion of the format definition
TKIOVersion	50	The version of TKIO used to create I/O routines to write this file. TKIOVersion does not define the format used to write this file.
MetadataStyle	50	The style in which the metadata was written, e.g., ”PVL”. ”PVL” means < parameter >=< value >;
EndianType	50	The endian type of the system that wrote this file. Values are ”BIG ENDIAN” and ”LITTLE ENDIAN”.

2.2.1.5 XCALinfo

XCALinfo contains metadata required by 1C intercalibrated files.

Table 2.2-5 XCALinfo Group

Metadata Element	Estimated Size (bytes)	Description
CalibrationStandard	50	The brightness temperature reference standard, e.g., ”cc 1.1”.
CalibrationTable	50	The name of a file containing the calibration table used to make this product, e.g., ”1C.AQUA.ASMRE.XCAL2013-P.tbl”.
CalibrationLevel	50	The level development of the intercalibration for a given sensor. When this level increases for a given sensor the Level 1C files are reprocessed and the version number will also increment. The intercalibration level is defined as follows: N (None): No intercalibration has been applied. Tbs are unchanged from Level 1B source files.

Metadata Element	Estimated Size (bytes)	Description
		P (Preliminary): A preliminary or beta intercalibration has been applied to match the Tb to the reference. V (Verified): The intercalibration has been verified by at least one independent effort. C (Consensus): The XCAL intercalibration has been finalized and accepted by the Science Team.

2.2.2. Data Group

Elements of data group are explained in detail in this section.

2.2.2.1 S1 (Swath)

(1) S1_SwathHeader (Metadata)

S1_SwathHeader contains metadata for swaths.

Table 2.2-6 S1_SwathHeader Group

Metadata Element	Estimated Size (bytes)	Description
NumberScansInSet	50	The scans read by TKreadScan are a ”set”. For single swath data, one scan is read so NumberScansInSet=1. For multiple swath data, one TKreadScan may read more than one scan. For example, for SSM/I data one TKreadScan reads one low frequency scan and two high frequency scans. Therefore NumberScansInSet=1 for the low frequency swath and NumberScansInSet=2 for the high frequency swath.
MaximumNumberScansTotal	50	The maximum allowed number of total scans in this swath. Total scans = overlap scans before granule + scans in granule + overlap scans after granule.
NumberScansBeforeGranule	50	The number of overlap scans before the first scan of the granule in this swath.
NumberScansGranule	50	The number of scans in the granule in this swath.
NumberScansAfterGranule	50	The number of overlap scans after the last scan of the granule in this swath.
NumberPixels	50	The number of IFOV in each scan in this swath.
ScanType	50	The type of scan in this swath. Values are: ”CROSSTRACK” and ”CONICAL”

(2) S1_IncidenceAngleIndex (Metadata)

S1_IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array.

Table 2.2-7 S1_IncidenceAngleIndex Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	S1_IncidenceAngleIndex	-99	0	100	-	1-byte integer	1 x 7 x nscan1	1	nchannel1	nscan1	1

(3) ScanTime (Group in S1)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan1)

4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:

-9999 Missing value

Month (1-byte integer, array size: nscan1)

Month of the year. Values range from 1 to 12 months. Special values are defined as:

-99 Missing value

DayOfMonth (1-byte integer, array size: nscan1)

Day of the month. Values range from 1 to 31 days. Special values are defined as:

-99 Missing value

Hour (1-byte integer, array size: nscan1)

UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:

-99 Missing value

Minute (1-byte integer, array size: nscan1)

Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:

-99 Missing value

Second (1-byte integer, array size: nscan1)

Second of the minute. Values range from 0 to 60 s. Special values are defined as:

-99 Missing value

MilliSecond (2-byte integer, array size: nscan1)

Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:

-9999 Missing value

DayOfYear (2-byte integer, array size: nscan1)

Day of the year. Values range from 1 to 366 days. Special values are defined as:

-9999 Missing value

SecondOfDay (8-byte float, array size: nscan1)

A time associated with the scan. scanTime sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:

-9999.9 Missing value

Table 2.2-8 ScanTime Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Yea	-9999	1950	2100	[year]	2-byte integer	2 x nscan1	2	nscan1	1	1
2	Month	-99	1	12	[month]	1-byte integer	1 x nscan1	1	nscan1	1	1
3	DayOFMonth	-99	1	31	[day]	1-byte integer	1 x nscan1	1	nscan1	1	1
4	Hour	-99	0	23	[hour]	1-byte integer	1 x nscan1	1	nscan1	1	1
5	Minute	-99	0	59	[minute]	1-byte integer	1 x nscan1	1	nscan1	1	1
6	Second	-99	0	60	[s]	1-byte integer	1 x nscan1	1	nscan1	1	1
7	MilliSecond	-9999	0	999	[ms]	2-byte integer	2 x nscan1	2	nscan1	1	1
8	DayOfYear	-9999	1	366	[day]	2-byte integer	2 x nscan1	2	nscan1	1	1
9	SecoundOfDay	-9999.9	0	86400	[s]	8-byte float	8 x nscan1	8	nscan1	1	1

(4) Latitude (4-byte float, array size: npixel1 x nscan1)

The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:

-9999.9 Missing value

Table 2.2-9 Latitude Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Latitude	-9999.9	-90	90	[degrees]	4-byte float	4 x 104 x nscan1	4	npixel1	nscan1	1

(5) Longitude (4-byte float, array size: npixel1 x nscan1)

The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:

-9999.9 Missing value

Table 2.2-10 Longitude Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Longitude	-9999.9	-180	180	[degree]	4-byte float	4 x 104 x nscan1	4	npixel1	nscan1	1

(6) SCstatus (Group in S1)

SCorientation (2-byte integer, array size: nscan1)

The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:

-9999 Missing value

SClatitude (4-byte float, array size: nscan1)

Values range from -90 to 90 degrees. Special values are defined as:

-9999.9 Missing value

SClongitude (4-byte float, array size: nscan1)

Values range from -180 to 180 degrees. Special values are defined as:

-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan1)

Values range from 0 to 1000 km. Special values are defined as:

-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan1)

The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:

-9999.9 Missing value

Table 2.2-11 SCStatus Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	SCorientation	-9999	0	360	[degree]	2-byte integer	2 x nscan1	2	nscan1	1	1
2	SClatitude	-9999.9	-90	90	[degree]	4-byte float	4 x nscan1	4	nscan1	1	1
3	SClongitude	-9999.9	-180	180	[degree]	4-byte float	4 x nscan1	4	nscan1	1	1
4	SCaltitude	-9999.9	0	1000	[km]	4-byte float	4 x nscan1	4	nscan1	1	1
5	FranctionalGranleNumber	-9999.9	0	100000		8-byte float	8 x nscan1	8	nscan1	1	1

(7) Quality (1-byte integer, array size: npixel1 x nscan1)

Quality of Tc in the swath.

GENERAL SPECIFICATIONS

0 = Good data in all channels in the swath

gt 0 = Cautionary warning flags
1-99 = Generic flags (all sensors)
100-127 = Sensor specific flags
lt 0 = Major errors resulting in missing data
-(1-98) = Generic flags (all sensors)
-99 = Missing value (no quality information available)
-(100-127) = Sensor specific flags

DETAILED SPECIFICATIONS
0 = Good data
1 = Possible sun glint
2 = Possible radio frequency interference
3 = Degraded geolocation data
4 = Data corrected for warm load intrusion
-1 = Data is missing from file or unreadable
-2 = Unphysical brightness temperature (Tb lt 50K or 350K gt Tb)
-3 = Error in geolocation data
-4 = Data missing in one channel
-5 = Data missing in multiple channels
-6 = Lat/lon values are out of range
-7 = Non-normal status modes
-10 = Distance to corresponding LF pixel > 7 km
(Used in L1C-R product only)
-99 = Missing value (no quality information available)

Table 2.2-12 Quality Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Quality	-99	-	-	-	1-byte integer	1 x 104 x nscan1	1	npixel1	nscan1	1

(8) incidenceAngle (4-byte float, array size: nchUIA1 x npixel1 x nscan1)

Earth incidence angle. Values range from 0 to 90 degrees. Special values are defined as:

-9999.9 Missing value

Table 2.2-13 incidenceAngle Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	incidenceAngle	-9999.9	0	90	[degree]	4-byte float	4 x 4 x 104 x nscan1	4	nchUIA1	npixel1	nscan1

(9) sunGlintAngle (1-byte integer, array size: nchUIA1 x npixel1 x nscan1)

Sun glint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees. Sun below horizon value is -88.

-99 Missing value

Table 2.2-14 sunGlintAngle Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	incidenceAngle	-99	0	127	[degree]	1-byte integer	4 x 4 x 104 x nscan1	1	nchUIA1	npixel1	nscan1

(10) incidenceAngleIndex (1-byte integer, array size: nchannel1 x nscan1)

Values range from 0 to 100. Special values are defined as:

-99 Missing value

Table 2.2-15 incidenceAngleIndex Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	incidenceAngleIndex	-99	0	100	-	1-byte integer	1 x 7 x nscan1	1	nchannel1	nscan1	1

(11) Tc (4-byte float, array size: nchannel1 x npixel1 x nscan1)

GPM Common Calibrated Brightness Temperature. The channels are:
10.7 GHz vertically-polarized TBs
10.7 GHz horizontally-polarized TBs
19.4 GHz vertically-polarized TBs
19.4 GHz horizontally-polarized TBs
22.3 GHz vertically-polarized TBs
37.0 GHz vertically-polarized TBs
37.0 GHz horizontally-polarized TBs

Values range from 0 to 10000 K. Special values are defined as:
-9999.9 Missing value

Table 2.2-16 Tc Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Tc	-9999.9	0	10000	[K]	4-byte float	4 x 7 x 104 x nscan1	4	nchannel1	npixel1	nscan1

2.2.2.2 S2 (Swath)

(1) S2_SwathHeader (Metadata)

S2_SwathHeader contains metadata for swaths.

Table 2.2-17 S2_SwathHeader Group

Metadata Element	Estimated Size (bytes)	Description
NumberScansInSet	50	The scans read by TKreadScan are a ”set”. For single swath data, one scan is read so NumberScansInSet=1. For multiple swath data, one TKreadScan may read more than one scan. For example, for SSM/I data one TKreadScan reads one low frequency scan and two high frequency scans. Therefore NumberScansInSet=1 for the low frequency swath and NumberScansInSet=2 for the high frequency swath.
MaximumNumberScansTotal	50	The maximum allowed number of total scans in this swath. Total scans = overlap scans before granule + scans in granule + overlap scans after granule.
NumberScansBeforeGranule	50	The number of overlap scans before the first scan of the granule in this swath.
NumberScansGranule	50	The number of scans in the granule in this swath.
NumberScansAfterGranule	50	The number of overlap scans after the last scan of the granule in this swath.
NumberPixels	50	The number of IFOV in each scan in this swath.
ScanType	50	The type of scan in this swath. Values are: ”CROSSTRACK” and ”CONICAL”

(2) S2_IncidenceAngleIndex (Metadata)

S2_IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array. See the description of the data array incidenceAngleIndex for details.

Table 2.2-18 S2_IncidenceAngleIndex Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	S2_IncidenceAngleIndex	-99	0	100	-	1-byte integer	1 x 2 x nscan2	1	nchannel2	nscan2	1

(3) ScanTime (Group in S2)

Year (2-byte integer, array size: nscan2)

4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:

-9999 Missing value

Month (1-byte integer, array size: nscan2)

Month of the year. Values range from 1 to 12 months. Special values are defined as:

-99 Missing value

DayOfMonth (1-byte integer, array size: nscan2)

Day of the month. Values range from 1 to 31 days. Special values are defined as:

-99 Missing value

Hour (1-byte integer, array size: nscan2)

UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:

-99 Missing value

Minute (1-byte integer, array size: nscan2)

Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:

-99 Missing value

Second (1-byte integer, array size: nscan2)

Second of the minute. Values range from 0 to 60 s. Special values are defined as:

-99 Missing value

MilliSecond (2-byte integer, array size: nscan2)

Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:

-9999 Missing value

DayOfYear (2-byte integer, array size: nscan2)

Day of the year. Values range from 1 to 366 days. Special values are defined as:

-9999 Missing value

SecondOfDay (8-byte float, array size: nscan2)

A time associated with the scan. scanTime sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:

-9999.9 Missing value

Table 2.2-19 ScanTime Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Year	-9999	1950	2100	[year]	2-byte integer	2 x nscan2	2	nscan2	1	1
2	Month	-99	1	12	[month]	1-byte integer	1 x nscan2	1	nscan2	1	1
3	DayOFMonth	-99	1	31	[day]	1-byte integer	1 x nscan2	1	nscan2	1	1
4	Hour	-99	0	23	[hour]	1-byte integer	1 x nscan2	1	nscan2	1	1
5	Minute	-99	0	59	[minute]	1-byte integer	1 x nscan2	1	nscan2	1	1
6	Second	-99	0	60	[s]	1-byte integer	1 x nscan2	1	nscan2	1	1
7	MilliSecond	-9999	0	999	[ms]	2-byte integer	2 x nscan2	2	nscan2	1	1
8	DayOfYear	-9999	1	366	[day]	2-byte integer	2 x nscan2	2	nscan2	1	1
9	SecoundOfDay	-9999.9	0	86400	[s]	8-byte float	8 x nscan2	8	nscan2	1	1

(4) Latitude (4-byte float, array size: npixel2 x nscan2)

The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:

-9999.9 Missing value

Table 2.2-20 Latitude Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Latitude	-9999.9	-90	90	[degree]	4-byte float	4 x 208 x nscan2	4	npixel2	nscan2	1

(5) Longitude (4-byte float, array size: npixel2 x nscan2)

The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:

-9999.9 Missing value

Table 2.2-21 Longitude Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Longitude	-9999.9	-180	180	[degree]	4-byte float	4 x 208 x nscan2	4	npixel2	nscan2	1

(6) SCstatus (Group in S2)

SCorientation (2-byte integer, array size: nscan2)

The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:

-9999 Missing value

SClatitude (4-byte float, array size: nscan2)

Values range from -90 to 90 degrees. Special values are defined as:

-9999.9 Missing value

SClongitude (4-byte float, array size: nscan2)

Values range from -180 to 180 degrees. Special values are defined as:

-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan2)

Values range from 0 to 1000 km. Special values are defined as:

-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan2)

The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:

-9999.9 Missing value

Table 2.2-22 SCStatus Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	SCorientation	-9999	0	360	[degree]	2-byte integer	2 x nscan2	2	nscan2	1	1
2	SClatitude	-9999.9	-90	90	[degree]	4-byte float	4 x nscan2	4	nscan2	1	1
3	SClongitude	-9999.9	-180	180	[degree]	4-byte float	4 x nscan2	4	nscan2	1	1
4	SCaltitude	-9999.9	0	1000	[km]	4-byte float	4 x nscan2	4	nscan2	1	1
5	FranctionalGranleNumber	-9999.9	0	100000	-	8-byte float	8 x nscan2	8	nscan2	1	1

(7) Quality (1-byte integer, array size: npixel2 x nscan2)

Quality of Tc in the swath.

GENERAL SPECIFICATIONS

0 = Good data in all channels in the swath

gt 0 = Cautionary warning flags

1-99 = Generic flags (all sensors)

100-127 = Sensor specific flags

lt 0 = Major errors resulting in missing data

-(1-98) = Generic flags (all sensors)

-99 = Missing value (no quality information available)

-(100-127) = Sensor specific flags

DETAILED SPECIFICATIONS

0 = Good data
1 = Possible sun glint
2 = Possible radio frequency interference
3 = Degraded geolocation data
4 = Data corrected for warm load intrusion
-1 = Data is missing from file or unreadable
-2 = Unphysical brightness temperature (Tb lt 50K or 350K gt Tb)
-3 = Error in geolocation data
-4 = Data missing in one channel
-5 = Data missing in multiple channels
-6 = Lat/lon values are out of range
-7 = Non-normal status modes
-10 = Distance to corresponding LF pixel > 7 km
(Used in L1C-R product only)
-99 = Missing value (no quality information available)

Table 2.2-23 Quality Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Quality	-99	-	-	-	1-byte integer	1 x 208 x nscan2	1	npixel2	nscan2	1

(8) incidenceAngle (4-byte float, array size: nchUIA2 x npixel2 x nscan2)

Earth incidence angle. Values range from 0 to 90 degrees. Special values are defined as:

-9999.9 Missing value

Table 2.2-24 incidenceAngle Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	incidenceAngle	-9999.9	0	90	[degree]	4-byte float	4 x 1 x 208 x nscan2	4	nchUIA2	npixel2	nscan2

(9) sunGlintAngle (1-byte integer, array size: nchUIA2 x npixel2 x nscan2)

Sun glint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees. Sun below horizon value is -88.

-99 Missing value

Table 2.2-25 sunGlintAngle Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	sunGlintAngle	-99	0	127	[degree]	1-byte integer	1 x 1 x 208 x nscan2	1	nchUIA2	npixel2	nscan2

(10) incidenceAngleIndex (1-byte integer, array size: nchannel2 x nscan2)

Values range from 0 to 100. Special values are defined as:

-99 Missing value

Table 2.2-26 incidenceAngleIndex Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	incidenceAngleIndex	-99	0	100	-	1-byte integer	1 x 2 x nscan2	1	nchannel2	nscan2	1

(11) Tc (4-byte float, array size: nchannel2 x npixel2 x nscan2)

GPM Common Calibrated Brightness Temperature. The channels are:
85.5 GHz vertically-polarized TBs
85.5 GHz horizontally-polarized TBs

Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

Table 2.2-27 Tc Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Tc	-9999.9	0	10000	[K]	4-byte float	4 x 2 x 208 x nscan2	4	nchannel2	npixel2	nscan2

2.2.2.3 S3 (Swath)

(1) S3_SwathHeader (Metadata)

S3_SwathHeader contains metadata for swaths.

Table 2.2-28 S3_SwathHeader Group

Metadata Element	Estimated Size (bytes)	Description
NumberScansInSet	50	The scans read by TKreadScan are a ”set”. For single swath data, one scan is read so NumberScansInSet=1. For multiple swath data, one TKreadScan may read more than one scan. For example, for SSM/I data one TKreadScan reads one low frequency scan and two high frequency scans. Therefore NumberScansInSet=1 for the low frequency swath and NumberScansInSet=2 for the high frequency swath.
MaximumNumberScansTotal	50	The maximum allowed number of total scans in this swath. Total scans = overlap scans before granule + scans in granule + overlap scans after granule.
NumberScansBeforeGranule	50	The number of overlap scans before the first scan of the granule in this swath.
NumberScansGranule	50	The number of scans in the granule in this swath.
NumberScansAfterGranule	50	The number of overlap scans after the last scan of the granule in this swath.
NumberPixels	50	The number of IFOV in each scan in this swath.
ScanType	50	The type of scan in this swath. Values are: ”CROSSTRACK” and ”CONICAL”

(2) S3_IncidenceAngleIndex (Metadata)

S3_IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array. See the description of the data array incidenceAngleIndex for details.

Table 2.2-29 S3_IncidenceAngleIndex Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	S3_IncidenceAngleIndex	-99	0	100	-	1-byte integer	1 x 2 x nscan3	1	nchannel3	nscan3	1

(3) ScanTime (Group in S3)

Year (2-byte integer, array size: nscan3)

4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan3)

Month of the year. Values range from 1 to 12 months. Special values are defined as:

-99 Missing value

DayOfMonth (1-byte integer, array size: nscan3)

Day of the month. Values range from 1 to 31 days. Special values are defined as:

-99 Missing value

Hour (1-byte integer, array size: nscan3)

UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:

-99 Missing value

Minute (1-byte integer, array size: nscan3)

Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:

-99 Missing value

Second (1-byte integer, array size: nscan3)

Second of the minute. Values range from 0 to 60 s. Special values are defined as:

-99 Missing value

MilliSecond (2-byte integer, array size: nscan3)

Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:

-9999 Missing value

DayOfYear (2-byte integer, array size: nscan3)

Day of the year. Values range from 1 to 366 days. Special values are defined as:

-9999 Missing value

SecondOfDay (8-byte float, array size: nscan3)

A time associated with the scan. scanTime sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:

-9999.9 Missing value

Table 2.2-30 ScanTime Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Year	-9999	1950	2100	[year]	2-byte integer	2 x nscan3	2	nscan3	1	1
2	Month	-99	1	12	[month]	1-byte integer	1 x nscan3	1	nscan3	1	1
3	DayOFMonth	-99	1	31	[day]	1-byte integer	1 x nscan3	1	nscan3	1	1
4	Hour	-99	0	23	[hour]	1-byte integer	1 x nscan3	1	nscan3	1	1
5	Minute	-99	0	59	[minute]	1-byte integer	1 x nscan3	1	nscan3	1	1
6	Second	-99	0	60	[s]	1-byte integer	1 x nscan3	1	nscan3	1	1
7	MilliSecond	-9999	0	999	[ms]	2-byte integer	2 x nscan3	2	nscan3	1	1
8	DayOfYear	-9999	1	366	[day]	2-byte integer	2 x nscan3	2	nscan3	1	1
9	SecoundOfDay	-9999.9	0	86400	[s]	8-byte float	8 x nscan3	8	nscan3	1	1

(4) Latitude (4-byte float, array size: npixel3 x nscan3)

The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:

-9999.9 Missing value

Table 2.2-31 Latitude Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Latitude	-9999.9	-90	90	[degree]	4-byte float	4 x 208 x nscan3	4	npixel3	nscan3	1

(5) Longitude (4-byte float, array size: npixel3 x nscan3)

The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:

-9999.9 Missing value

Table 2.2-32 Longitude Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Longitude	-9999.9	-180	180	[degree]	4-byte float	4 x 208 x nscan3	4	npixel3	nscan3	1

(6) SCstatus (Group in S3)

SCorientation (2-byte integer, array size: nscan3)

The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:

-9999 Missing value

SClatitude (4-byte float, array size: nscan3)

Values range from -90 to 90 degrees. Special values are defined as:

-9999.9 Missing value

SClongitude (4-byte float, array size: nscan3)

Values range from -180 to 180 degrees. Special values are defined as:

-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan3)

Values range from 0 to 1000 km. Special values are defined as:

-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan3)

The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:

-9999.9 Missing value

Table 2.2-33 SCStatus Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	SCorientation	-9999	0	360	[degree]	2-byte integer	2 x nscan3	2	nscan3	1	1
2	SClatitude	-9999.9	-90	90	[degree]	4-byte float	4 x nscan3	4	nscan3	1	1
3	SClongitude	-9999.9	-180	180	[degree]	4-byte float	4 x nscan3	4	nscan3	1	1
4	SCaltitude	-9999.9	0	1000	[km]	4-byte float	4 x nscan3	4	nscan3	1	1
5	FranctionalGranleNumber	-9999.9	0	100000	-	8-byte float	8 x nscan3	8	nscan3	1	1

(7) Quality (1-byte integer, array size: npixel3 x nscan3)

Quality of Tc in the swath.

GENERAL SPECIFICATIONS
0 = Good data in all channels in the swath
gt 0 = Cautionary warning flags
1-99 = Generic flags (all sensors)
100-127 = Sensor specific flags
lt 0 = Major errors resulting in missing data
-(1-98) = Generic flags (all sensors)
-99 = Missing value (no quality information available)
-(100-127) = Sensor specific flags

DETAILED SPECIFICATIONS
0 = Good data
1 = Possible sun glint
2 = Possible radio frequency interference
3 = Degraded geolocation data
4 = Data corrected for warm load intrusion
-1 = Data is missing from file or unreadable
-2 = Unphysical brightness temperature (Tb lt 50K or 350K gt Tb)
-3 = Error in geolocation data
-4 = Data missing in one channel
-5 = Data missing in multiple channels
-6 = Lat/lon values are out of range
-7 = Non-normal status modes
-10 = Distance to corresponding LF pixel > 7 km
(Used in L1C-R product only)
-99 = Missing value (no quality information available)

Table 2.2-34 Quality Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Quality	-99	-	-	-	1-byte integer	1 x 208 x nscan3	1	npixel3	nscan3	1

(8) incidenceAngle (4-byte float, array size: nchUIA3 x npixel3 x nscan3)

Earth incidence angle. the angle of the satellite from the local zenith as seen at the pixel location on the earth.Values range from 0 to 90 degrees. Special values are defined as:

-9999.9 Missing value

Table 2.2-35 incidenceAngle Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	incidenceAngle	-9999.9	0	90	[degree]	4-byte float	4 x 1 x 208 x nscan3	4	nchUIA3	npixel3	nscan3

(9) sunGlintAngle (1-byte integer, array size: nchUIA3 x npixel3 x nscan3)

Sun glint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees. Sun below horizon value is -88.

-99 Missing value

Table 2.2-36 sunGlintAngle Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	sunGlintAngle	-99	0	127	[degree]	1-byte integer	1 x 1 x 208 x nscan3	1	nchUIA3	npixel3	nscan3

(10) incidenceAngleIndex (1-byte integer, array size: nchannel3 x nscan3)

Index (1 based as in Fortran) of the incidence angle array corresponding to the channel.

For example, if the swath has 10 channels and 2 unique incidence angles, then the dimensions in Fortran would be:

incidenceAngle(2,npixel,nscan)
sunGlintAngle(2,npixel,nscan)
incidenceAngleIndex(10,nscan)
Tc(10,npixel,nscan)

The user would do the following to retreive the angles for a given channel, pixel, and scan:

i = incidenceAngleIndex(channel,scan)
ia = incidenceAngle(i,pixel,scan)
sga = sunGlintAngle(i,pixel,scan)

The incidenceAngleIndex is the same for every scan, but is repeated each scan for the convenience of users reading the data scan by scan. In addition, incidenceAngleIndex is located in metadata for the convenience of users wishing to read this information from metadata.

Values range from 0 to 100. Special values are defined as:

-99 Missing value

Table 2.2-37 incidenceAngleIndex Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	incidenceAngleIndex	-99	0	100	-	1-byte integer	1 x 2 x nscan3	1	nchannel3	nscan3	1

(11) Tc (4-byte float, array size: nchannel3 x npixel3 x nscan3)

GPM Common Calibrated Brightness Temperature. The channels are:

85.5 GHz vertically-polarized TBs
85.5 GHz horizontally-polarized TBs

Values range from 0 to 400 K. Special values are defined as:

-9999.9 Missing value

Table 2.2-38 Tc Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Tc	-9999.9	0	10000	[K]	4-byte float	4 x 2 x 208 x nscan3	4	nchannel3	npixel3	nscan3

3. 1CAMSR2 – Common Calibrated Brightness Temperature

3.1. Data Format Structure

3.1.1. Dimension definition

Dimension definitions:

- nscan1
  - var Number of scans in Swath S1 in the granule.
- nscan2
  - var Number of scans in Swath S2 in the granule.
- nscan3
  - var Number of scans in Swath S3 in the granule.
- nscan4
  - var Number of scans in Swath S4 in the granule.
- nscan5
  - var Number of scans in Swath S5 in the granule.
- nscan6
  - var Number of scans in Swath S6 in the granule.
- npixel1
  - 243 Number of Swath S1 pixels in one scan.
- npixel2
  - 243 Number of Swath S2 pixels in one scan.
- npixel3
  - 243 Number of Swath S3 pixels in one scan.
- npixel4
  - 243 Number of Swath S4 pixels in one scan.
- npixel5
  - 486 Number of Swath S5 pixels in one scan.
- npixel6
  - 486 Number of Swath S6 pixels in one scan.
- nchannel1
  - 2 Number of Swath S1 channels.
- nchannel2
  - 2 Number of Swath S2 channels.
- nchannel3
  - 2 Number of Swath S3 channels.
- nchannel4
  - 2 Number of Swath S4 channels.
- nchannel5
  - 2 Number of Swath S5 channels.
- nchannel6
  - 2 Number of Swath S6 channels.
- nchUIA1
  - 1 Number of Swath S1 unique incidence angles.
- nchUIA2
  - 1 Number of Swath S2 unique incidence angles.
- nchUIA3
  - 1 Number of Swath S3 unique incidence angles.
- nchUIA4
  - 1 Number of Swath S4 unique incidence angles.
- nchUIA5
  - 1 Number of Swath S5 unique incidence angles.
- nchUIA6
  - 1 Number of Swath S6 unique incidence angles.

3.1.2. Data Format Structure for 1CAMSR2 – Common Calibrated Brightness Temperature

1CAMSR2 contains common calibrated brightness temperature from the AMSR2 passive microwave instrument flown on the GCOMW1 satellite. This products contains 6 swaths. Swath 1 has channels 10.65V 10.65H. Swath 2 has channels 18.7V 18.7H. Swath 3 has channels 23.8V 23.8H. Swath 4 has channels 36.5V 36.5H. Swath S5 has 2 high frequency A-Scan channels (89V,89H). Swath S6 has 2 high frequency B-Scan channels (89V,89H). Data for all six swaths is observed in the same revolution of the instrument. High frequency A and high frequency B data are observed in separate feedhorns. RELATION BETWEEN THE SWATHS: Each S1 scan contains 10 GHz channels sampled 243 times along the scan. S2, S3, and S4 are sampled nominally at the same position as the S1 samples, but differ by small distances. Each S5 scan contains high frequency A channels sampled 486 times along the scan. Each S6 scan contains high frequency B channels sampled 486 times along the scan. Both Swath S5 and Swath S6 have exactly twice as many pixels as Swath S1. S1 pixels 1, 2, 3, ... coincide with S5 pixels 1, 3, 5, ... Scans of all swaths are repeated every 1.5s and the scans of one swath are about 10km apart along the direction of the satellite track. Along an S1 scan every other center of an S5 pixel coincides with the center of an S1 pixel, but the S6 pixels are offset from S1 and S2 pixels by nominally 15km in the direction normal to the scan direction on the aft side, in other words S6 pixels are nominally 15km ”behind” the S1 and S5 pixels for the same scan.

The Figure below shows the locations of the pixels of scans 1 and 2 for swaths S1, S5, and S6. Since swaths S2, S3 and S4 are close to S1, they are omitted from the figure. Each ”+” represents centers of pixels from one or more swaths. For example, the label ”S1:1,2 S5:1,3” means that both Swath S1, Scan 1, Pixel 2 and Swath S5, Scan 1, Pixel 3 are located at the ”+”.

S6:1, 1	S6:1, 2	S6:1, 3		S6:1, 391	S6:1, 392
+	+	+	…..	+	+
S6:2, 1	S6:2, 2	S6:2, 3		S6:2, 391	S6:2, 392
+	+	+	…..	+	+
S1:1, 1 S5:1, 1	S5:1, 2	S1:1, 2 S5:1, 3		S1:1, 196 S5:1, 391	S5:1, 392
+	+	+	…..	+	+
S1:2, 1 S5:2, 1	S5:2, 2	S1:2, 2 S5:2, 3		S1:2, 196 S5:2, 391	S5:2, 392
+	+	+	…..	+	+

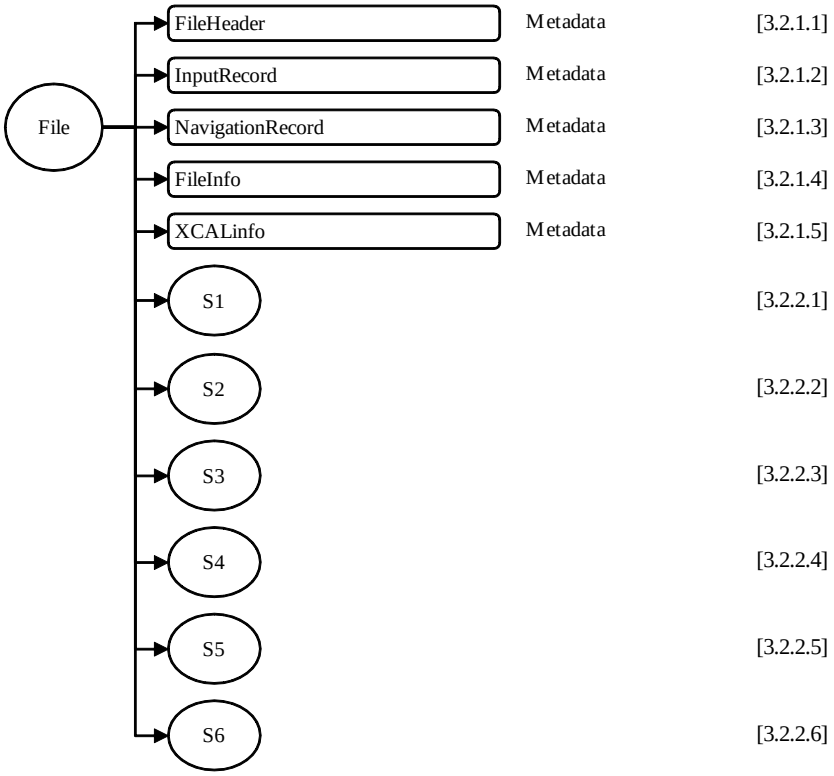

Figure 3.1-1 Data Format Structure for 1CAMSR2 – Common Calibrated Brightness Temperature

3.1.3. Data Format Structure for each Group

3.1.3.1 Data Format Structure for S1 Group

S1 Group's structure is shown in this section.

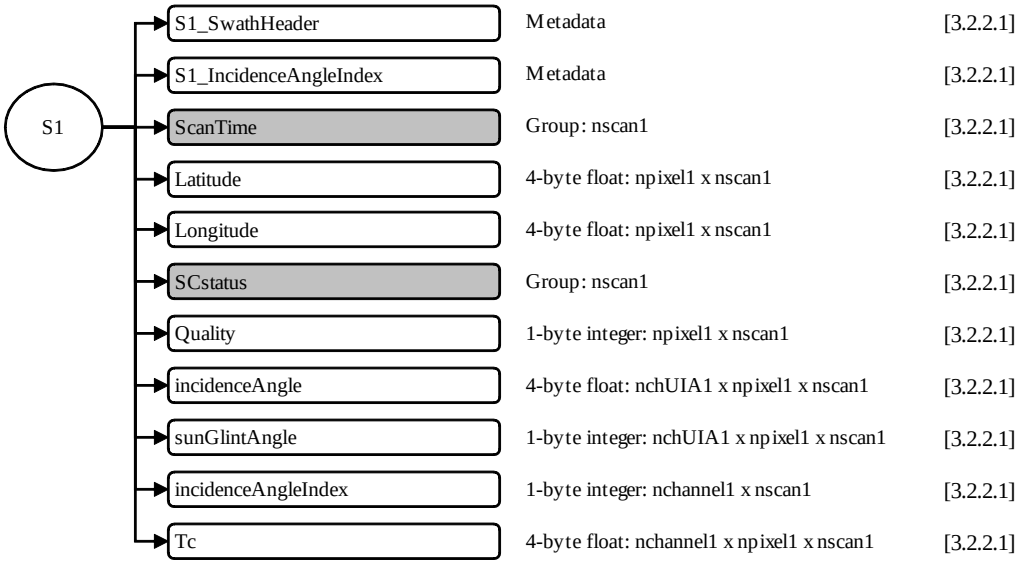

Figure 3.1-2 Data Format Structure for 1CAMSR2, S1

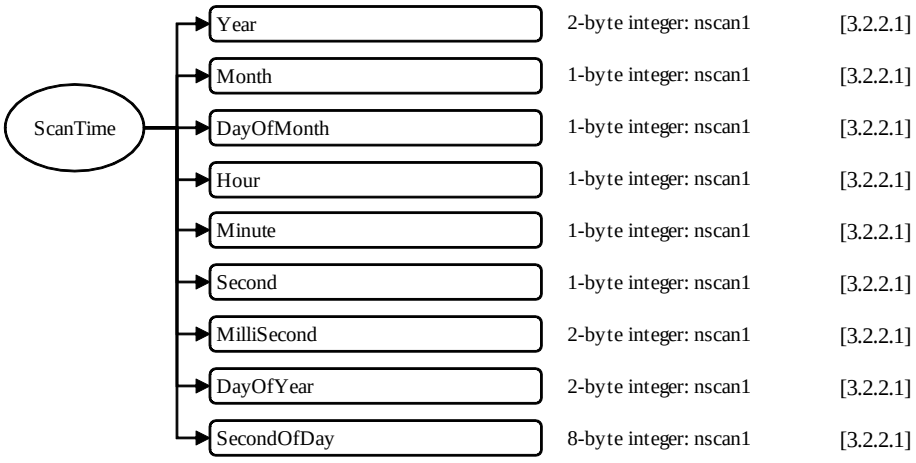

Figure 3.1-3 Data Format Structure for 1CAMSR2, ScanTime

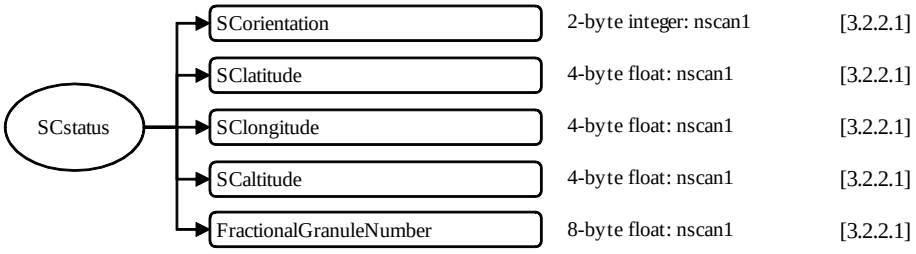

Figure 3.1-4 Data Format Structure for 1CAMSR2, SCstatus

3.1.3.2 Data Format Structure for S2 Group

S2 Group's structure is shown in this section.

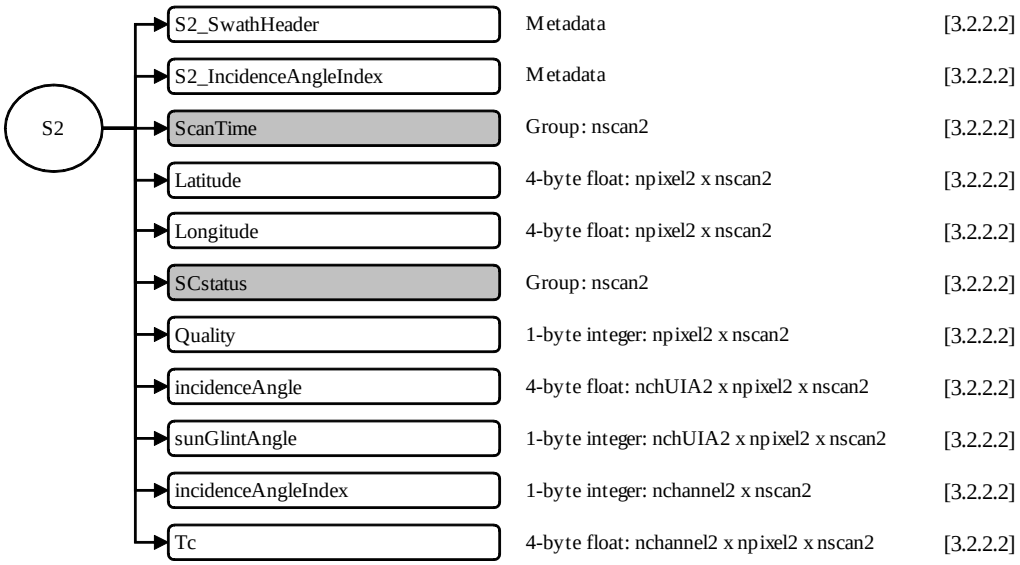

Figure 3.1-5 Data Format Structure for 1CAMSR2, S2

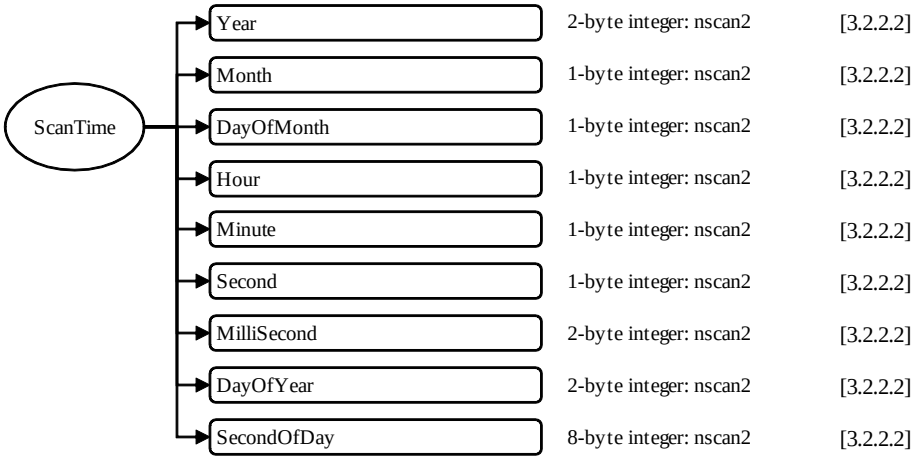

Figure 3.1-6 Data Format Structure for 1CAMSR2, S2, ScanTime

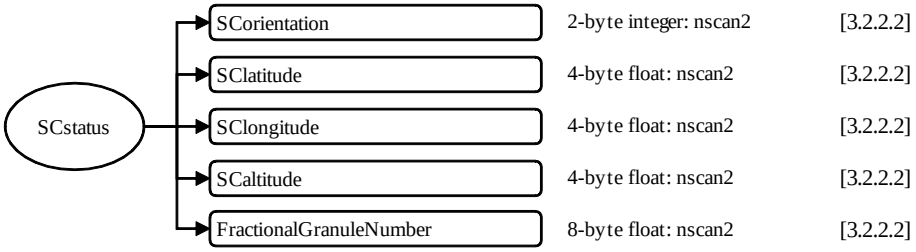

Figure 3.1-7 Data Format Structure for 1CAMSR2, S2, SCstatus

3.1.3.3 Data Format Structure for S3 Group

S3 Group's structure is shown in this section.

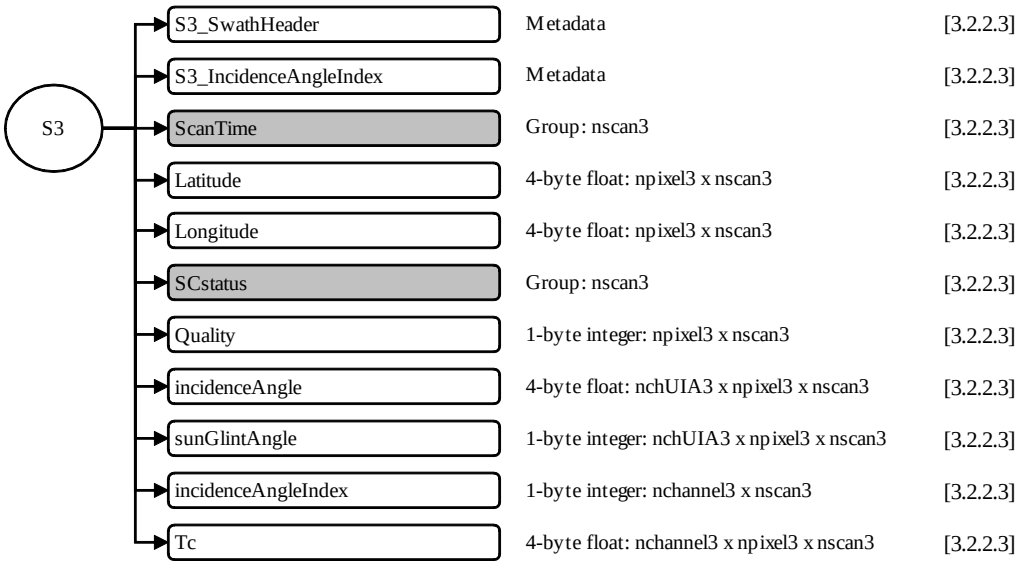

Figure 3.1-8 Data Format Structure for 1CAMSR2, S3

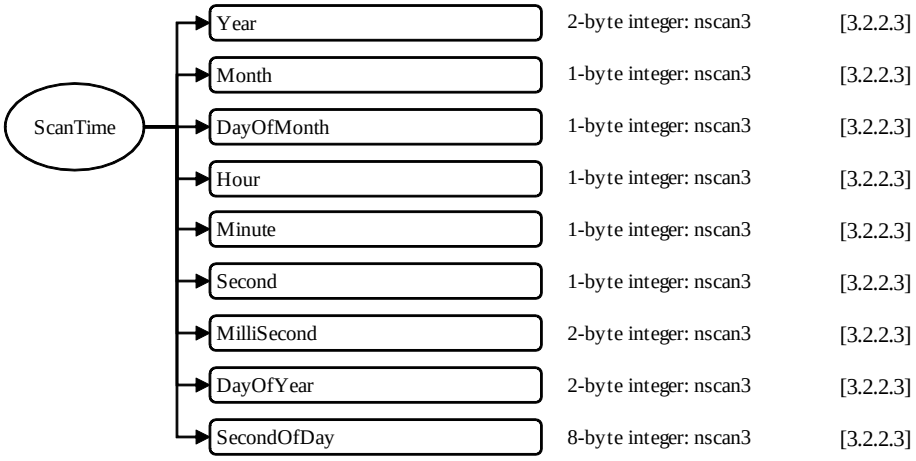

Figure 3.1-9 Data Format Structure for 1CAMSR2, S3, ScanTime

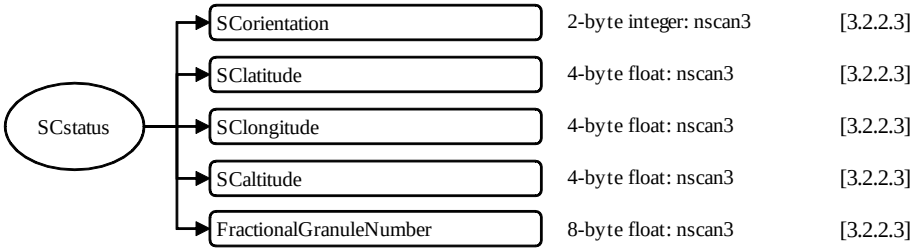

Figure 3.1-10 Data Format Structure for 1CAMSR2, S3, SCstatus

3.1.3.4 Data Format Structure for S4 Group

S4 Group's structure is shown in this section.

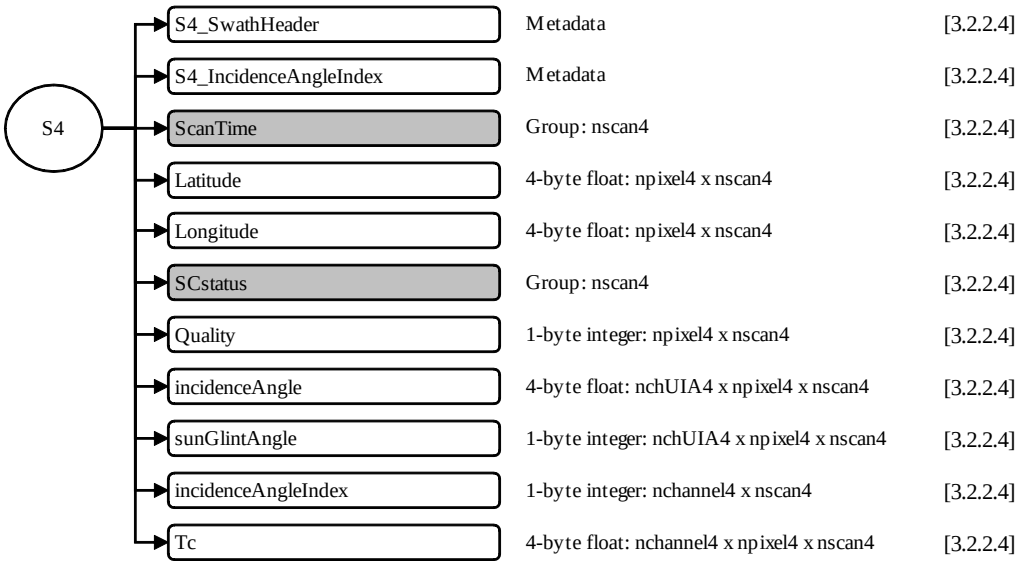

Figure 3.1-11 Data Format Structure for 1CAMSR2, S4

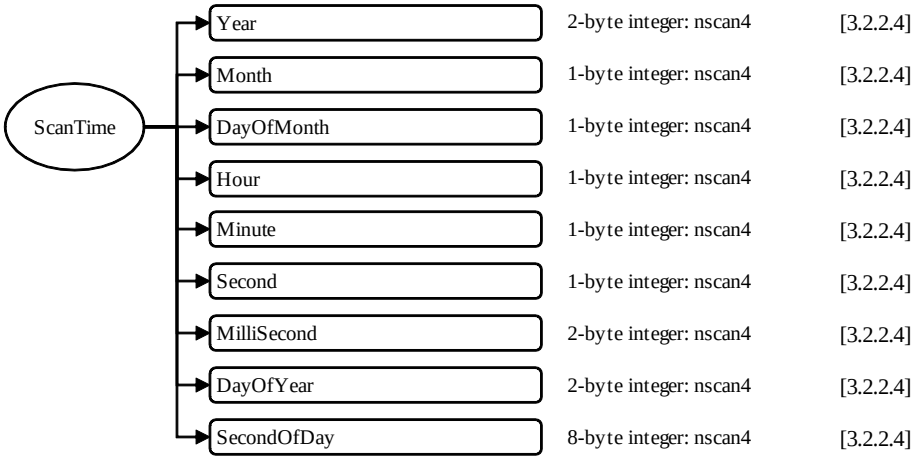

Figure 3.1-12 Data Format Structure for 1CAMSR2, S4, ScanTime

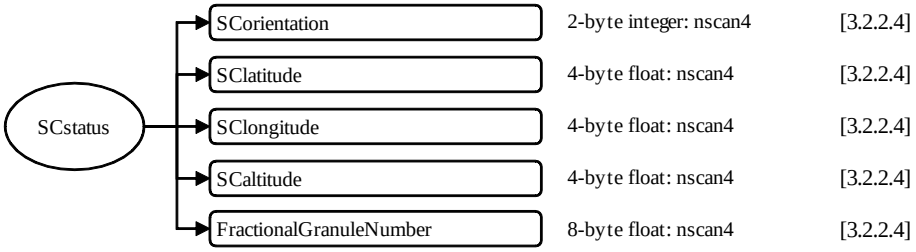

Figure 3.1-13 Data Format Structure for 1CAMSR2, S4, SCstatus

3.1.3.5 Data Format Structure for S5 Group

S5 Group's structure is shown in this section.

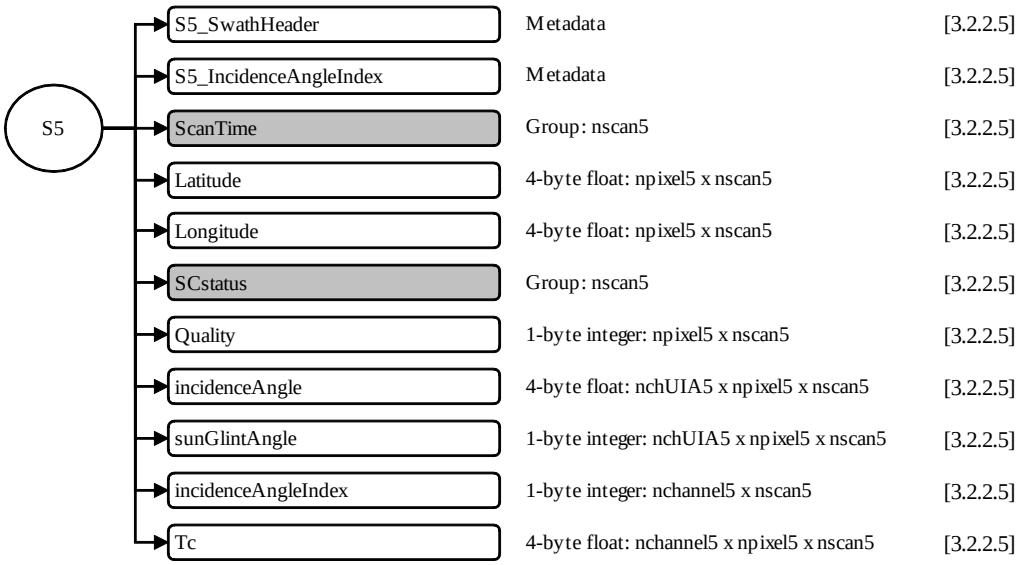

Figure 3.1-14 Data Format Structure for 1CAMSR2, S5

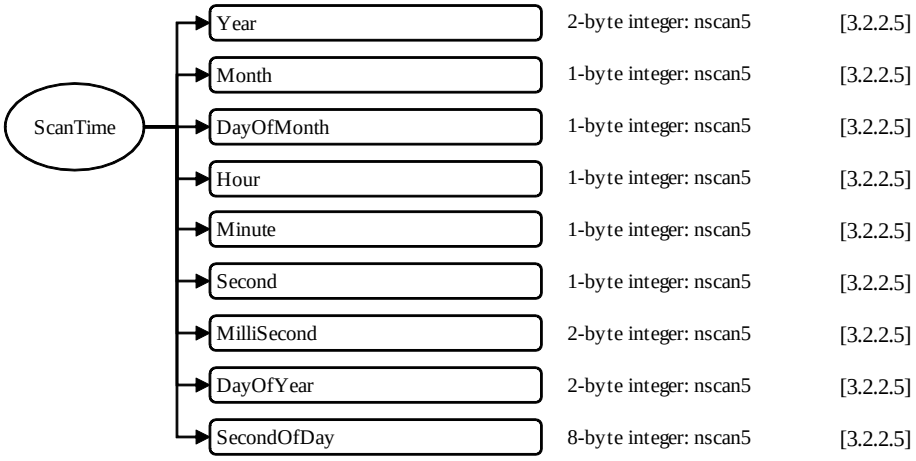

Figure 3.1-15 Data Format Structure for 1CAMSR2, S5, ScanTime

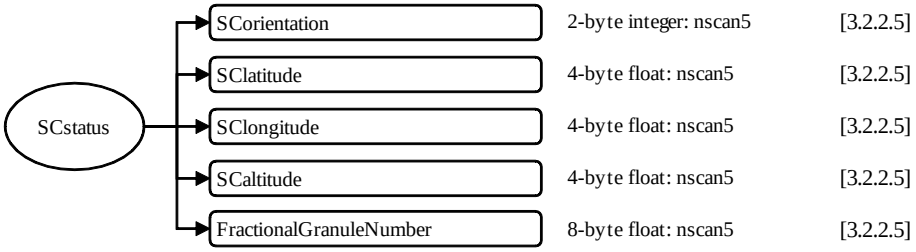

Figure 3.1-16 Data Format Structure for 1CAMSR2, S5, SCstatus

3.1.3.6 Data Format Structure for S6 Group

S6 Group's structure is shown in this section.

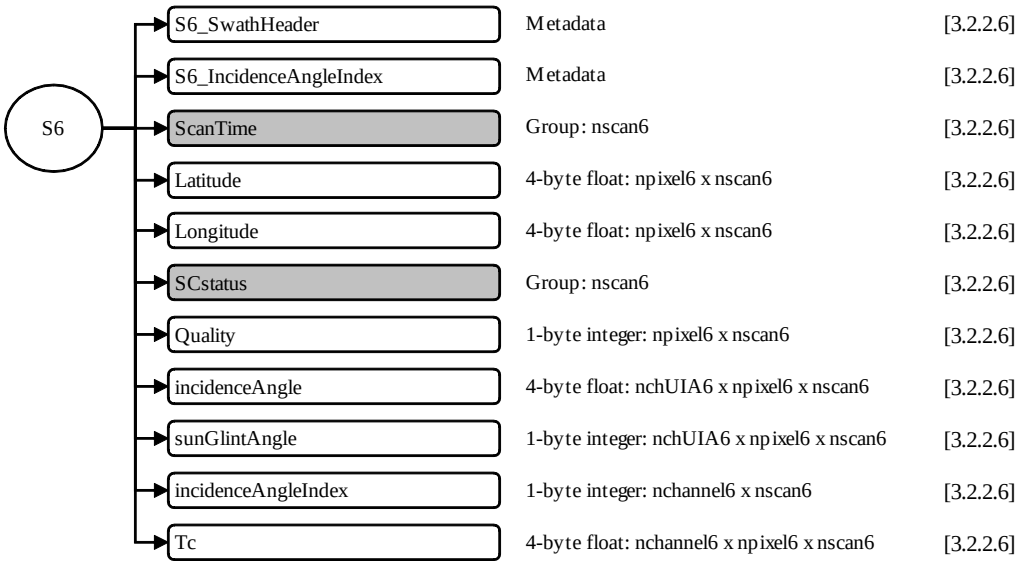

Figure 3.1-17 Data Format Structure for 1CAMSR2, S6

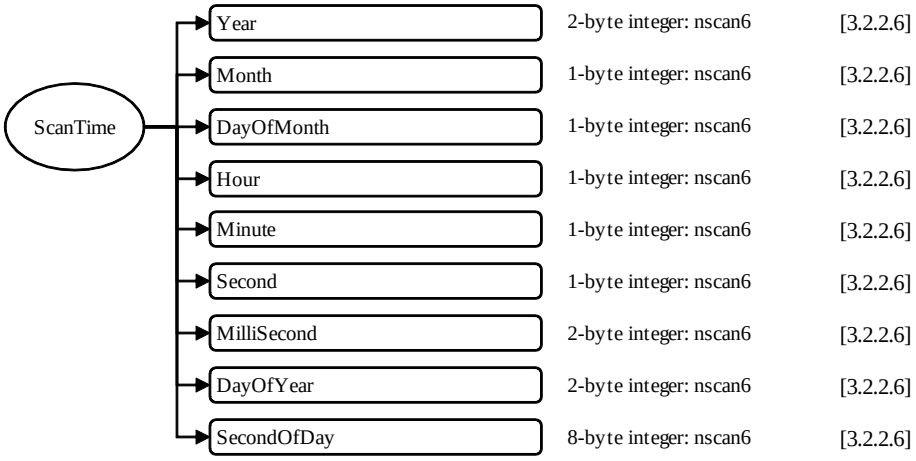

Figure 3.1-18 Data Format Structure for 1CAMSR2, S6, ScanTime

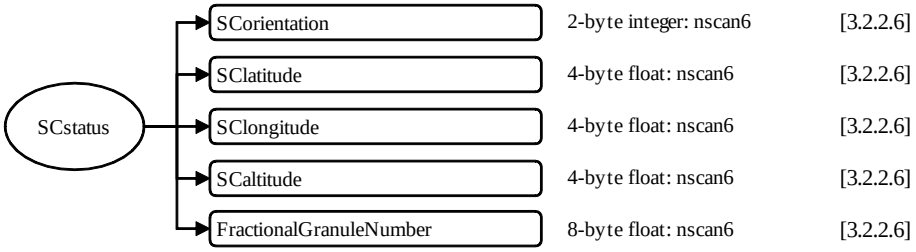

Figure 3.1-19 Data Format Structure for 1CAMSR2, S6, SCstatus

3.2. Contents of objects in each Group

3.2.1. Metadata

3.2.1.1 FileHeader

FileHeader contains metadata of general interest. Table 3.2-1 shows each metadata elements in FileHeader.

Table 3.2-1 FileHeader Group

Metadata Element	Estimated Size (bytes)	Description
DOI	256	Digital Object Identifier *Value is blank currently
DOIauthority	256	Digital Object Identifier Authority.
DOIshortName	256	Digital Object Identifier Short Name. *Value is blank currently.
AlgorithmID	50	The algorithm that generated this product, e.g., 2A12.
AlgorithmVersion	50	The version of the algorithm that generated this product.
FileName	50	The file name of this granule.
SatelliteName	10	Values are: TRMM GPM MULTI F10 ... F18 AQUA GCOMW1 CORIOLIS MT1 NOAA15 ... NOAA19 METOPANPP. More values will be added as they are known.
InstrumentName	10	Values are: PR TMI VIRS PRTMI KU KA DPR GMI DPRGMI MERGED SSMI SSMIS AMSRE AMSR2 WIND-SAT MADRAS AMSUA AMSUB SAPHIR MHS ATMS. More values will be added as they are known.
GenerationDateTime	50	The date and time this granule was generated. The format is YYYY-MM-DDTHH:MM:SS.sssZ, where YYYY is 4-digit year, MM is month number, DD is day of month, T is ”T”, HH is hour, MM is minute, SS is second, sss is millisecond, and Z is ”Z”. All fields are zero-filled. The missing value is constructed by replacing all digits with 9, i.e., 9999-99-99T99:99:99.999Z
StartGranuleDateTime	50	The start time defining this granule. The format is the same as GenerationDateTime. DETAILS: An orbital granule starts when the satellite is at the position defined by GranuleStart. Thus the start time is not the first scan time. Some algorithms have overlap scans in the file before the start time as defined in SwathHeader. A monthly granule starts on the first ms of the month, for example March 1998 would be 1998-03-01T00:00:00.000Z
StopGranuleDateTime	50	The stop time defining this granule. The format is the same as GenerationDateTime. DETAILS: An orbital granule stops when the satellite is at the position defined by GranuleStart. Thus the stop time is not the last scan time. Some algorithms have overlap scans in the file after the stop time as defined in SwathHeader. A monthly granule stops on the last ms of the month, for example March 1998 would be 1998-03-31T23:59:59.999Z
GranuleNumber	50	The number of this granule, which starts as in GranuleStart. If the GranuleStart is identical to the orbit start, then the GranuleNumber will be the same as the orbit number. The GranuleNumber will have 6 digits, including leading zeroes, for example 001234.
NumberOfSwaths	50	The number of swaths in this granule.
NumberOfGrids	50	The number of grid structures in this granule.
GranuleStart	50	The starting place in the orbit of this granule. Currently defined values are ”SOUTHERNMOST LATITUDE” and ”NORTHBOUND EQUATOR CROSSING”.
TimeInterval	50	The time interval covered by this granule. Values are ”ORBIT”, ”HALF ORBIT”, ”HALF HOUR”, ”HOUR”, ”3 HOUR”, ”DAY”, ”MONTH”, ”CONTACT”.

Metadata Element	Estimated Size (bytes)	Description
ProcessingSystem	50	The name of the processing system, e.g., ”PPS”, ”JAXA”.
ProductVersion	50	The data version assigned by the processing system.
EmptyGranule	50	Whether a granule is empty. Values are ”EMPTY” or ”NOT EMPTY”.
MissingData	50	The number of missing scans.

3.2.1.2 InputRecord

InputRecord contains a record of input files for this granule. Table 3.2-2 shows each metadata elements in InputRecord.

Table 3.2-2 InputRecord Group

Metadata Element	Estimated Size (bytes)	Description
InputFileName	1000	A list of input file names for this granule.
InputAlgorithmVersions	1000	A list of algorithm versions of the input files for this granule.
InputGenerationDatteTimes	1000	A list of generation date times of the input files for this granule. The format is the same as GenerationDateTime.

3.2.1.3 NavigationRecord

NavigationRecord contains navigation metadata for this granule. Table 3.2-3 shows each metadata elements in NavigationRecord.

Table 3.2-3 NavigationRecord Group

Metadata Element	Estimated Size (bytes)	Description
LongitudeOnEquator	50	The longitude where the satellite crosses the equator going from south to north.
UTCDateTimeOnEquator	50	The UTC time when the satellite crosses the equator going from south to north. The format is the same as GenerationDate Time.
MeanSolarBetaAngle	50	The average solar beta angle in this granule.
EphemerisFileName	50	Name of the ephemeris file input for processing.
AttitudeFileName	50	Name of the attitude file input for processing.
GeoControlFileName	50	Name of the GeoTK Control Parameters File input for processing.
EphemerisSource	50	Values are ”0 CONSTANT INPUT TEST VALUE”, ”1 GROUND ESTIMATED STATE (GES)”, ”2 GPS FILTERED SOLUTION (GEONS)”, ”3 GPS POINT SOLUTION (PVT)”, ”4 ON BOARD PROPAGATED (OBP)”, ”5 OEM GROUND EPHEMERIS FILE”, ”6 GEONS WITH FALLBACK AS FLAGGED”, ”7 PVT WITH FALLBACK AS FLAGGED”, ”8 OBP WITH FALLBACK AS FLAGGED”, ”9 GES WITH FALLBACK AS FLAGGED”
AttitudeSource	50	Values are ”0 CONSTANT INPUTS FOR TESTING”, ”1 ON BOARD CALCULATED PITCH ROLL YAW”
GeoToolkitVersion	50	Version of the GeoToolkit
SensorAlignmentFirstRotationAngle	50	Alignment angle, first rotation, in degrees. Rotation adjustment from sensor coordinates to the Attitude Control System Flight Coordinates.
SensorAlignmentSecondRotationAngle	50	Alignment angle, second rotation, in degrees.
SensorAlignmentThirdRotationAngle	50	Alignment angle, third rotation, in degrees.

Metadata Element	Estimated Size (bytes)	Description
SensorAlignmentFirstRotationAxis	50	Euler rotation sequence, first rotation axis. Values are ”1”, ”2”, ”3” (representing X, Y, Z).
SensorAlignmentSecondRotationAxis	50	Euler rotation sequence, second rotation axis. Values are ”1”, ”2”, ”3” (representing X, Y, Z).
SensorAlignmentThirdRotationAxis	50	Euler rotation sequence, third rotation axis. Values are ”1”, ”2”, ”3” (representing X, Y, Z).

3.2.1.4 FileInfo

FileInfo contains metadata used by the PPS I/O Toolkit. Table 3.2-4 shows each metadata elements in FileInfo.

Table 3.2-4 FileInfo Group

Metadata Element	Estimated Size (bytes)	Description
DataFormatVersion	50	The version of the data format used to write this file. This version is separate for each AlgorithmID. The order is: ”a” ”b” ... ”z” ”aa” ”ab” ... ”az” ”ba” ”bb” ...
TKCodeBuildVersion	50	Usually TK CodeBuildVersion is ”1”. If the I/O routines built by TKIO change even though the DataFormatVersion is unchanged, then TK CodeBuildVersion increments to ”2”, ”3”, ... If subsequently DataFormatVersion changes, TKCodeBuildVersion becomes ”1” again.
MetadataVersion	50	The version of metadata used to write this file. This version is separate for each AlgorithmID. The order is: ”a” ”b” ... ”z” ”aa” ”ab” ... ”az” ”ba” ”bb” ...
FormatPackage	50	The underlying format of this granule. Values are ”HDF4”, ”HDF5”, ”NETCDF”, ”TKBINARY”
BlueprintFilename	50	The filename of the primary blueprint file that defined the format used to write this file.
BlueprintVersion	10	The BlueprintVersion of the format definition
TKIOVersion	50	The version of TKIO used to create I/O routines to write this file. TKIOVersion does not define the format used to write this file.
MetadataStyle	50	The style in which the metadata was written, e.g., ”PVL”. ”PVL” means < parameter >=< value >;
EndianType	50	The endian type of the system that wrote this file. Values are ”BIG ENDIAN” and ”LITTLE ENDIAN”.

3.2.1.5 XCALinfo

XCALinfo contains metadata required by 1C intercalibrated files.

Table 3.2-5 XCALinfo Group

Metadata Element	Estimated Size (bytes)	Description
CalibrationStandard	50	The brightness temperature reference standard, e.g., ”cc 1.1”.
CalibrationTable	50	The name of a file containing the calibration table used to make this product, e.g., ”1C.AQUA.ASMRE.XCAL2013-P.tbl”.
CalibrationLevel	50	The level development of the intercalibration for a given sensor. When this level increases for a given sensor the Level 1C files are reprocessed and the version number will also increment. The intercalibration level is defined as follows: N (None): No intercalibration has been applied. Tbs are unchanged from Level 1B source files.

Metadata Element	Estimated Size (bytes)	Description
		P (Preliminary): A preliminary or beta intercalibration has been applied to match the Tb to the reference. V (Verified): The intercalibration has been verified by at least one independent effort. C (Consensus): The XCAL intercalibration has been finalized and accepted by the Science Team.

3.2.2. Data Group

Elements of data group are explained in detail in this section.

3.2.2.1 S1 (Swath)

(1) S1_SwathHeader (Metadata)

S1_SwathHeader contains metadata for swaths.

Table 3.2-6 S1_SwathHeader Group

Metadata Element	Estimated Size (bytes)	Description
NumberScansInSet	50	The scans read by TKreadScan are a ”set”. For single swath data, one scan is read so NumberScansInSet=1. For multiple swath data, one TKreadScan may read more than one scan. For example, for SSM/I data one TKreadScan reads one low frequency scan and two high frequency scans. Therefore NumberScansInSet=1 for the low frequency swath and NumberScansInSet=2 for the high frequency swath.
MaximumNumberScansTotal	50	The maximum allowed number of total scans in this swath. Total scans = overlap scans before granule + scans in granule + overlap scans after granule.
NumberScansBeforeGranule	50	The number of overlap scans before the first scan of the granule in this swath.
NumberScansGrAnule	50	The number of scans in the granule in this swath.
NumberScansAfterGranule	50	The number of overlap scans after the last scan of the granule in this swath.
NumberPixels	50	The number of IFOV in each scan in this swath.
ScanType	50	The type of scan in this swath. Values are: ”CROSSTRACK” and ”CONICAL”

(2) S1_IncidenceAngleIndex (Metadata)

S1_IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array.

Table 3.2-7 S1_IncidenceAngleIndex Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	S1_IncidenceAngleIndex	-99	0	100	-	1-byte integer	1 x 2 x nscan1	1	nchannel1	nscan1	1

(3) ScanTime (Group in S1)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan1)

4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:

-9999 Missing value

Month (1-byte integer, array size: nscan1)

Month of the year. Values range from 1 to 12 months. Special values are defined as:

-99 Missing value

DayOfMonth (1-byte integer, array size: nscan1)

Day of the month. Values range from 1 to 31 days. Special values are defined as:

-99 Missing value

Hour (1-byte integer, array size: nscan1)

UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:

-99 Missing value

Minute (1-byte integer, array size: nscan1)

Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:

-99 Missing value

Second (1-byte integer, array size: nscan1)

Second of the minute. Values range from 0 to 60 s. Special values are defined as:

-99 Missing value

MilliSecond (2-byte integer, array size: nscan1)

Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:

-9999 Missing value

DayOfYear (2-byte integer, array size: nscan1)

Day of the year. Values range from 1 to 366 days. Special values are defined as:

-9999 Missing value

SecondOfDay (8-byte float, array size: nscan1)

A time associated with the scan. scanTime sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:

-9999.9 Missing value

Table 3.2-8 ScanTime Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Year	-9999	1950	2100	[year]	2-byte int	2 x nscan1	2	nscan1	1	1
2	Month	-99	1	12	[month]	1-byte integer	1 x nscan1	1	nscan1	1	1
3	DayOFMonth	-99	1	31	[day]	1-byte integer	1 x nscan1	1	nscan1	1	1
4	Hour	-99	0	23	[hour]	1-byte integer	1 x nscan1	1	nscan1	1	1
5	Minute	-99	0	59	[minute]	1-byte integer	1 x nscan1	1	nscan1	1	1
6	Second	-99	0	60	[s]	1-byte integer	1 x nscan1	1	nscan1	1	1
7	MilliSecond	-9999	0	999	[ms]	2-byte integer	2 x nscan1	2	nscan1	1	1
8	DayOfYear	-9999	1	366	[day]	2-byte integer	2 x nscan1	2	nscan1	1	1
9	SecoundOfDay	-9999.9	0	86400	[s]	8-byte float	8 x nscan1	8	nscan1	1	1

(4) Latitude (4-byte float, array size: npixel1 x nscan1)

Nominal latitude of the observation point on the earth surface at low frequency. This was calculated by applying the 23 GHz coregistration parameters to the 89A GHz location.

Table 3.2-9 Latitude Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Latitude	-9999.9	-90	90	[degree]	4-byte float	4 x 243 x nscan1	4	npixel1	nscan1	1

(5) Longitude (4-byte float, array size: npixel1 x nscan1)

Nominal longitude of the observation point on the earth surface at low frequency. This was calculated by applying the 23 GHz coregistration parameters to the 89A GHz location.

Table 3.2-10 Longitude Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Longitude	-9999.9	-180	180	[degree]	4-byte float	4 x 243 x nscan1	4	npixel1	nscan1	1

(6) SCstatus (Group in S1)

SCorientation (2-byte integer, array size: nscan1)

The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:

-9999 Missing value

SClatitude (4-byte float, array size: nscan1)

Values range from -90 to 90 degrees. Special values are defined as:

-9999.9 Missing value

SClongitude (4-byte float, array size: nscan1)

Values range from -180 to 180 degrees. Special values are defined as:

-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan1)

Values range from 0 to 1000 km. Special values are defined as:

-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan1)

The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:

-9999.9 Missing value

Table 3.2-11 SCStatus Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	SCorientation	-9999	0	360	[degree]	2-byte integer	2 x nscan1	2	nscan1	1	1
2	SClatitude	-9999.9	-90	90	[degree]	4-byte float	4 x nscan1	4	nscan1	1	1
3	SClongitude	-9999.9	-180	180	[degree]	4-byte float	4 x nscan1	4	nscan1	1	1
4	SCaltitude	-9999.9	0	1000	[km]	4-byte float	4 x nscan1	4	nscan1	1	1
5	FranctionalGranleNumber	-9999.9	0	100000	-	8-byte float	8 x nscan1	8	nscan1	1	1

(7) Quality (1-byte integer, array size: npixel1 x nscan1)

Quality of Tc in the swath.

GENERAL SPECIFICATIONS
0 = Good data in all channels in the swath
gt 0 = Cautionary warning flags
1-99 = Generic flags (all sensors)
100-127 = Sensor specific flags
lt 0 = Major errors resulting in missing data
-(1-98) = Generic flags (all sensors)
-99 = Missing value (no quality information available)
-(100-127) = Sensor specific flags
DETAILED SPECIFICATIONS
0 = Good data
1 = Possible sun glint
2 = Possible radio frequency interference
3 = Degraded geolocation data
4 = Data corrected for warm load intrusion
-1 = Data is missing from file or unreadable
-2 = Unphysical brightness temperature (Tb lt 50K or 350K gt Tb)
-3 = Error in geolocation data
-4 = Data missing in one channel
-5 = Data missing in multiple channels
-6 = Lat/lon values are out of range
-7 = Non-normal status modes
-10 = Distance to corresponding LF pixel > 7 km
(Used in L1C-R product only)
-99 = Missing value (no quality information available)

Table 3.2-12 Quality Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Quality	-99	-	-	-	1-byte integer	1 x 243 x nscan1	1	npixel1	nscan1	1

(8) incidenceAngle (4-byte float, array size: nchUIA1 x npixel1 x nscan1)

Earth incidence angle. Values range from 0 to 90 degrees. Special values are defined as:

-9999.9 Missing value

Table 3.2-13 incidenceAngle Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	incidenceAngle	-9999.9	0	90	[degree]	4-byte float	4 x 1 x 243 x nscan1	4	nchUIA1	npixel1	nscan1

(9) sunGlintAngle (1-byte integer, array size: nchUIA1 x npixel1 x nscan1)

Sun glint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees. Sun below horizon value is -88.

-99 Missing value

Table 3.2-14 sunGlintAngle Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	incidenceAngle	-99	0	127	[degree]	1-byte integer	4 x 1 x 243 x nscan1	1	nchUIA1	npixel1	nscan1

(10) incidenceAngleIndex (1-byte integer, array size: nchannel1 x nscan1)

Values range from 0 to 100. Special values are defined as:

-99 Missing value

Table 3.2-15 incidenceAngleIndex Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	incidenceAngleIndex	-99	0	100	-	1-byte integer	1 x 2 x nscan1	1	nchannel1	nscan1	1

(11) Tc (4-byte float, array size: nchannel1 x npixel1 x nscan1)

GPM Common Calibrated Brightness Temperature. The channels are:

10.65 GHz vertically-polarized TBs
10.65 GHz horizontally-polarized TBs

Table 3.2-16 Tc Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Tc	-9999.9	0	10000	[K]	4-byte float	4 x 2 x 243 x nscan1	4	nchannel1	npixel1	nscan1

3.2.2.2 S2 (Swath)

(1) S2_SwathHeader (Metadata)

S2_SwathHeader contains metadata for swaths.

Table 3.2-17 S2_SwathHeader Group

Metadata Element	Estimated Size (bytes)	Description
NumberScansInSet	50	The scans read by TKreadScan are a ”set”. For single swath data, one scan is read so NumberScansInSet=1. For multiple swath data, one TKreadScan may read more than one scan. For example, for SSM/I data one TKreadScan reads one low frequency scan and two high frequency scans. Therefore NumberScansInSet=1 for the low frequency swath and NumberScansInSet=2 for the high frequency swath.
MaximumNumberScansTotal	50	The maximum allowed number of total scans in this swath. Total scans = overlap scans before granule + scans in granule + overlap scans after granule.
NumberScansBeforeGranule	50	The number of overlap scans before the first scan of the granule in this swath.
NumberScansGrAnule	50	The number of scans in the granule in this swath.
NumberScansAfterGranule	50	The number of overlap scans after the last scan of the granule in this swath.
NumberPixels	50	The number of IFOV in each scan in this swath.
ScanType	50	The type of scan in this swath. Values are: ”CROSSTRACK” and ”CONICAL”

(2) S2_IncidenceAngleIndex (Metadata)

S2_IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array.

Table 3.2-18 S2_IncidenceAngleIndex Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	S2_IncidenceAngleIndex	-99	0	100	-	1-byte integer	1 x 2 x nscan2	1	nchannel2	nscan2	1

(3) ScanTime (Group in S2)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan2)

4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:

-9999 Missing value

Month (1-byte integer, array size: nscan2)

Month of the year. Values range from 1 to 12 months. Special values are defined as:

-99 Missing value

DayOfMonth (1-byte integer, array size: nscan2)

Day of the month. Values range from 1 to 31 days. Special values are defined as:

-99 Missing value

Hour (1-byte integer, array size: nscan2)

UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:

-99 Missing value

Minute (1-byte integer, array size: nscan2)

Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:

-99 Missing value

Second (1-byte integer, array size: nscan2)

Second of the minute. Values range from 0 to 60 s. Special values are defined as:

-99 Missing value

MilliSecond (2-byte integer, array size: nscan2)

Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:

-9999 Missing value

DayOfYear (2-byte integer, array size: nscan2)

Day of the year. Values range from 1 to 366 days. Special values are defined as:

-9999 Missing value

SecondOfDay (8-byte float, array size: nscan2)

A time associated with the scan. scanTime sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:

-9999.9 Missing value

Table 3.2-19 ScanTime Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Year	-9999	1950	2100	[year]	2-byte integer	2 x nscan2	2	nscan2	1	1
2	Month	-99	1	12	[month]	1-byte integer	1 x nscan2	1	nscan2	1	1
3	DayOFMonth	-99	1	31	[day]	1-byte integer	1 x nscan2	1	nscan2	1	1
4	Hour	-99	0	23	[hour]	1-byte integer	1 x nscan2	1	nscan2	1	1
5	Minute	-99	0	59	[minute]	1-byte integer	1 x nscan2	1	nscan2	1	1
6	Second	-99	0	60	[s]	1-byte integer	1 x nscan2	1	nscan2	1	1
7	MilliSecond	-9999	0	999	[ms]	2-byte integer	2 x nscan2	2	nscan2	1	1
8	DayOfYear	-9999	1	366	[day]	2-byte integer	2 x nscan2	2	nscan2	1	1
9	SecoundOfDay	-9999.9	0	86400	[s]	8-byte float	8 x nscan2	8	nscan2	1	1

(4) Latitude (4-byte float, array size: npixel2 x nscan2)

Nominal latitude of the observation point on the earth surface at low frequency. This was calculated by applying the 23 GHz coregistration parameters to the 89A GHz location.

Table 3.2-20 Latitude Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Latitude	-9999.9	-90	90	[degree]	4-byte float	4 x 243 x nscan2	4	npixel2	nscan2	1

(5) Longitude (4-byte float, array size: npixel2 x nscan2)

Nominal longitude of the observation point on the earth surface at low frequency. This was calculated by applying the 23 GHz coregistration parameters to the 89A GHz location.

Table 3.2-21 Longitude Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Longitude	-9999.9	-180	180	[degree]	4-byte float	4 x 243 x nscan2	4	npixel2	nscan2	1

(6) SCstatus (Group in S2)

SCorientation (2-byte integer, array size: nscan2)

The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:

-9999 Missing value

SClatitude (4-byte float, array size: nscan2)

Values range from -90 to 90 degrees. Special values are defined as:

-9999.9 Missing value

SClongitude (4-byte float, array size: nscan2)

Values range from -180 to 180 degrees. Special values are defined as:

-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan2)

Values range from 0 to 1000 km. Special values are defined as:

-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan2)

The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:

-9999.9 Missing value

Table 3.2-22 SCStatus Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	SCorientation	-9999	0	360	[degree]	2-byte integer	2 x nscan2	2	nscan2	1	1
2	SClatitude	-9999.9	-90	90	[degree]	4-byte float	4 x nscan2	4	nscan2	1	1
3	SClongitude	-9999.9	-180	180	[degree]	4-byte float	4 x nscan2	4	nscan2	1	1
4	SCaltitude	-9999.9	0	1000	[km]	4-byte float	4 x nscan2	4	nscan2	1	1
5	FranctionalGranleNumber	-9999.9	0	100000	-	8-byte float	8 x nscan2	8	nscan2	1	1

(7) Quality (1-byte integer, array size: npixel2 x nscan2)

Quality of Tc in the swath.

GENERAL SPECIFICATIONS
0 = Good data in all channels in the swath
gt 0 = Cautionary warning flags
1-99 = Generic flags (all sensors)

100-127 = Sensor specific flags
lt 0 = Major errors resulting in missing data
-(1-98) = Generic flags (all sensors)
-99 = Missing value (no quality information available)
-(100-127) = Sensor specific flags
DETAILED SPECIFICATIONS
0 = Good data
1 = Possible sun glint
2 = Possible radio frequency interference
3 = Degraded geolocation data
4 = Data corrected for warm load intrusion
-1 = Data is missing from file or unreadable
-2 = Unphysical brightness temperature (Tb lt 50K or 350K gt Tb)
-3 = Error in geolocation data
-4 = Data missing in one channel
-5 = Data missing in multiple channels
-6 = Lat/lon values are out of range
-7 = Non-normal status modes
-10 = Distance to corresponding LF pixel > 7 km
(Used in L1C-R product only)
-99 = Missing value (no quality information available)

Table 3.2-23 Quality Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Quality	-99	-	-	-	1-byte integer	1 x 243 x nscan2	1	npixel2	nscan2	1

(8) incidenceAngle (4-byte float, array size: nchUIA1 x npixel2 x nscan2)

Earth incidence angle. Values range from 0 to 90 degrees. Special values are defined as:

-9999.9 Missing value

Table 3.2-24 incidenceAngle Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	incidenceAngle	-9999.9	0	90	[degree]	4-byte float	4 x 1 x 243 x nscan2	4	nchUIA2	npixel2	nscan2

(9) sunGlintAngle (1-byte integer, array size: nchUIA2 x npixel2 x nscan2)

Sun glint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees. Sun below horizon value is -88.

-99 Missing value

Table 3.2-25 sunGlintAngle Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	sunGlintAngle	-99	0	127	[degree]	4-byte float	4 x 1 x 243 x nscan2	4	nchUIA2	npixel2	nscan2

(10) incidenceAngleIndex (1-byte integer, array size: nchannel2 x nscan2)

Values range from 0 to 100. Special values are defined as:

-99 Missing value

Table 3.2-26 incidenceAngleIndex Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	incidenceAngleIndex	-99	0	100	-	1-byte integer	1 x 2 x nscan2	1	nchannel2	nscan2	1

(11) Tc (4-byte float, array size: nchannel2 x npixel2 x nscan2)

GPM Common Calibrated Brightness Temperature. The channels are:

18.7 GHz vertically-polarized TBs
18.7 GHz horizontally-polarized TBs

Table 3.2-27 Tc Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Tc	-9999.9	0	10000	[K]	4-byte float	4 x 2 x 243 x nscan2	4	nchannel2	npixel2	nscan2

3.2.2.3 S3 (Swath)

(1) S3_SwathHeader (Metadata)

S3_SwathHeader contains metadata for swaths.

Table 3.2-28 S3_SwathHeader Group

Metadata Element	Estimated Size (bytes)	Description
NumberScansInSet	50	The scans read by TKreadScan are a ”set”. For single swath data, one scan is read so NumberScansInSet=1. For multiple swath data, one TKreadScan may read more than one scan. For example, for SSM/I data one TKreadScan reads one low frequency scan and two high frequency scans. Therefore NumberScansInSet=1 for the low frequency swath and NumberScansInSet=2 for the high frequency swath.
MaximumNumberScansTotal	50	The maximum allowed number of total scans in this swath. Total scans = overlap scans before granule + scans in granule + overlap scans after granule.
NumberScansBeforeGranule	50	The number of overlap scans before the first scan of the granule in this swath.
NumberScansGrAnule	50	The number of scans in the granule in this swath.
NumberScansAfterGranule	50	The number of overlap scans after the last scan of the granule in this swath.
NumberPixels	50	The number of IFOV in each scan in this swath.
ScanType	50	The type of scan in this swath. Values are: ”CROSSTRACK” and ”CONICAL”

(2) S3_IncidenceAngleIndex (Metadata)

S3_IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array.

Table 3.2-29 S3_IncidenceAngleIndex Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	S3_IncidenceAngleIndex	-99	0	100	-	1-byte integer	1 x 2 x nscna3	1	nchannel3	nscan3	1

(3) ScanTime (Group in S3)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan3)

4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:

-9999 Missing value

Month (1-byte integer, array size: nscan3)

Month of the year. Values range from 1 to 12 months. Special values are defined as:

-99 Missing value

DayOfMonth (1-byte integer, array size: nscan3)

Day of the month. Values range from 1 to 31 days. Special values are defined as:

-99 Missing value

Hour (1-byte integer, array size: nscan3)

UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:

-99 Missing value

Minute (1-byte integer, array size: nscan3)

Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:

-99 Missing value

Second (1-byte integer, array size: nscan3)

Second of the minute. Values range from 0 to 60 s. Special values are defined as:

-99 Missing value

MilliSecond (2-byte integer, array size: nscan3)

Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:

-9999 Missing value

DayOfYear (2-byte integer, array size: nscan3)

Day of the year. Values range from 1 to 366 days. Special values are defined as:

-9999 Missing value

SecondOfDay (8-byte float, array size: nscan3)

A time associated with the scan. scanTime sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:

-9999.9 Missing value

Table 3.2-30 ScanTime Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Year	-9999	1950	2100	[year]	2-byte integer	2 x nscan3	2	nscan3	1	1
2	Month	-99	1	12	[month]	1-byte integer	1 x nscan3	1	nscan3	1	1
3	DayOFMonth	-99	1	31	[day]	1-byte integer	1 x nscan3	1	nscan3	1	1
4	Hour	-99	0	23	[hour]	1-byte integer	1 x nscan3	1	nscan3	1	1
5	Minute	-99	0	59	[minute]	1-byte integer	1 x nscan3	1	nscan3	1	1
6	Second	-99	0	60	[s]	1-byte integer	1 x nscan3	1	nscan3	1	1
7	MilliSecond	-9999	0	999	[ms]	2-byte integer	2 x nscan3	2	nscan3	1	1
8	DayOfYear	-9999	1	366	[day]	2-byte integer	2 x nscan3	2	nscan3	1	1
9	SecoundOfDay	-9999.9	0	86400	[s]	8-byte float	8 x nscan3	8	nscan3	1	1

(4) Latitude (4-byte float, array size: npixel3 x nscan3)

Nominal latitude of the observation point on the earth surface at low frequency. This was calculated by applying the 23 GHz coregistration parameters to the 89A GHz location.

Table 3.2-31 Latitude Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Latitude	-9999.9	-90	90	[degree]	4-byte float	4 x 243 x nscan3	4	npixel3	nscan3	1

(5) Longitude (4-byte float, array size: npixel3 x nscan3)

Nominal longitude of the observation point on the earth surface at low frequency. This was calculated by applying the 23 GHz coregistration parameters to the 89A GHz location.

Table 3.2-32 Longitude Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Longitude	-9999.9	-180	180	[degree]	4-byte float	4 x 243 x nscan3	4	npixel3	nscan3	1

(6) SCstatus (Group in S3)

SCorientation (2-byte integer, array size: nscan3)

The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:

-9999 Missing value

SClatitude (4-byte float, array size: nscan3)

Values range from -90 to 90 degrees. Special values are defined as:

-9999.9 Missing value

SClongitude (4-byte float, array size: nscan3)

Values range from -180 to 180 degrees. Special values are defined as:

-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan3)

Values range from 0 to 1000 km. Special values are defined as:

-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan3)

The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:

-9999.9 Missing value

Table 3.2-33 SCStatus Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	SCorientation	-9999	0	360	[degree]	2-byte int	2 x nscan3	2	nscan3	1	1
2	SClatitude	-9999.9	-90	90	[degree]	4-byte float	4 x nscan3	4	nscan3	1	1
3	SClongitude	-9999.9	-180	180	[degree]	4-byte float	4 x nscan3	4	nscan3	1	1
4	SCaltitude	-9999.9	0	1000	[km]	4-byte float	4 x nscan3	4	nscan3	1	1
5	FranctionalGranleNumber	-9999.9	0	100000		8-byte float	8 x nscan3	8	nscan3	1	1

(7) Quality (1-byte integer, array size: npixel3 x nscan3)

Quality of Tc in the swath.

GENERAL SPECIFICATIONS
0 = Good data in all channels in the swath
gt 0 = Cautionary warning flags
1-99 = Generic flags (all sensors)

100-127 = Sensor specific flags
lt 0 = Major errors resulting in missing data
-(1-98) = Generic flags (all sensors)
-99 = Missing value (no quality information available)
-(100-127) = Sensor specific flags
DETAILED SPECIFICATIONS
0 = Good data
1 = Possible sun glint
2 = Possible radio frequency interference
3 = Degraded geolocation data
4 = Data corrected for warm load intrusion
-1 = Data is missing from file or unreadable
-2 = Unphysical brightness temperature (Tb lt 50K or 350K gt Tb)
-3 = Error in geolocation data
-4 = Data missing in one channel
-5 = Data missing in multiple channels
-6 = Lat/lon values are out of range
-7 = Non-normal status modes
-10 = Distance to corresponding LF pixel > 7 km
(Used in L1C-R product only)
-99 = Missing value (no quality information available)

Table 3.2-34 Quality Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Quality	-99	-	-	-	1-byte integer	1 x 243 x nscan3	1	npixel3	nscan3	1

(8) incidenceAngle (4-byte float, array size: nchUIA3 x npixel3 x nscan3)

Earth incidence angle. Values range from 0 to 90 degrees. Special values are defined as:

-9999.9 Missing value

Table 3.2-35 incidenceAngle Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	incidenceAngle	-9999.9	0	90	[degree]	4-byte float	4 x 1 x 243 x nscan3	4	nchUIA3	npixel3	nscan3

(9) sunGlintAngle (1-byte integer, array size: nchUIA3 x npixel3 x nscan3)

Sun glint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees. Sun below horizon value is -88.

-99 Missing value

Table 3.2-36 sunGlintAngle Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	sunGlintAngle	-99	0	127	[degree]	4-byte float	4 x 1 x 243 x nscan3	4	nchUIA3	npixel3	nscan3

(10) incidenceAngleIndex (1-byte integer, array size: nchannel3 x nscan3)

Values range from 0 to 100. Special values are defined as:

-99 Missing value

Table 3.2-37 incidenceAngleIndex Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	incidenceAngleIndex	-99	0	100	-	1-byte integer	1 x 2 x nscan3	1	nchannel3	nscan3	1

(11) Tc (4-byte float, array size: nchannel3 x npixel3 x nscan3)

GPM Common Calibrated Brightness Temperature. The channels are:

23.8 GHz vertically-polarized TBs
23.8 GHz horizontally-polarized TBs

Table 3.2-38 Tc Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Tc	-9999.9	0	10000	[K]	4-byte float	4 x 2 x 243 x nscan3	4	nchannel3	npixel3	nscan3

3.2.2.4 S4 (Swath)

(1) S4_SwathHeader (Metadata)

S4_SwathHeader contains metadata for swaths.

Table 3.2-39 S4_SwathHeader Group

Metadata Element	Estimated Size (bytes)	Description
NumberScansInSet	50	The scans read by TKreadScan are a ”set”. For single swath data, one scan is read so NumberScansInSet=1. For multiple swath data, one TKreadScan may read more than one scan. For example, for SSM/I data one TKreadScan reads one low frequency scan and two high frequency scans. Therefore NumberScansInSet=1 for the low frequency swath and NumberScansInSet=2 for the high frequency swath.
MaximumNumberScansTotal	50	The maximum allowed number of total scans in this swath. Total scans = overlap scans before granule + scans in granule + overlap scans after granule.
NumberScansBeforeGranule	50	The number of overlap scans before the first scan of the granule in this swath.
NumberScansGrAnule	50	The number of scans in the granule in this swath.
NumberScansAfterGranule	50	The number of overlap scans after the last scan of the granule in this swath.
NumberPixels	50	The number of IFOV in each scan in this swath.
ScanType	50	The type of scan in this swath. Values are: ”CROSSTRACK” and ”CONICAL”

(2) S4_IncidenceAngleIndex (Metadata)

S4_IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array.

Table 3.2-40 S4_IncidenceAngleIndex Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	S4_IncidenceAngleIndex	-99	0	100	-	1-byte integer	1 x 2 x nscan4	1	nchannel4	nscan4	1

(3) ScanTime (Group in S4)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan4)

4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:

-9999 Missing value

Month (1-byte integer, array size: nscan4)

Month of the year. Values range from 1 to 12 months. Special values are defined as:

-99 Missing value

DayOfMonth (1-byte integer, array size: nscan4)

Day of the month. Values range from 1 to 31 days. Special values are defined as:

-99 Missing value

Hour (1-byte integer, array size: nscan4)

UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:

-99 Missing value

Minute (1-byte integer, array size: nscan4)

Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:

-99 Missing value

Second (1-byte integer, array size: nscan4)

Second of the minute. Values range from 0 to 60 s. Special values are defined as:

-99 Missing value

MilliSecond (2-byte integer, array size: nscan4)

Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:

-9999 Missing value

DayOfYear (2-byte integer, array size: nscan4)

Day of the year. Values range from 1 to 366 days. Special values are defined as:

-9999 Missing value

SecondOfDay (8-byte float, array size: nscan4)

A time associated with the scan. scanTime sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:

-9999.9 Missing value

Table 3.2-41 ScanTime Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Year	-9999	1950	2100	[year]	2-byte int	2 x nscan4	2	nscan4	1	1
2	Month	-99	1	12	[month]	1-byte integer	1 x nscan4	1	nscan4	1	1
3	DayOFMonth	-99	1	31	[day]	1-byte integer	1 x nscan4	1	nscan4	1	1
4	Hour	-99	0	23	[hour]	1-byte integer	1 x nscan4	1	nscan4	1	1
5	Minute	-99	0	59	[minute]	1-byte integer	1 x nscan4	1	nscan4	1	1
6	Second	-99	0	60	[s]	1-byte integer	1 x nscan4	1	nscan4	1	1
7	MilliSecond	-9999	0	999	[ms]	2-byte int	2 x nscan4	2	nscan4	1	1
8	DayOfYear	-9999	1	366	[day]	2-byte int	2 x nscan4	2	nscan4	1	1
9	SecoundOfDay	-9999.9	0	86400	[s]	8-byte float	8 x nscan4	8	nscan4	1	1

(4) Latitude (4-byte float, array size: npixel4 x nscan4)

Nominal latitude of the observation point on the earth surface at low frequency. This was calculated by applying the 23 GHz coregistration parameters to the 89A GHz location.

Table 3.2-42 Latitude Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Latitude	-9999.9	-90	90	[degree]	4-byte float	4 x 243 x nscan4	4	npixel4	nscan4	1

(5) Longitude (4-byte float, array size: npixel4 x nscan4)

Nominal longitude of the observation point on the earth surface at low frequency. This was calculated by applying the 23 GHz coregistration parameters to the 89A GHz location.

Table 3.2-43 Longitude Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Longitude	-9999.9	-180	180	[degree]	4-byte float	4 x 243 x nscan4	4	npixel4	nscan4	1

(6) SCstatus (Group in S4)

SCorientation (2-byte integer, array size: nscan4)

The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:

-9999 Missing value

SClatitude (4-byte float, array size: nscan4)

Values range from -90 to 90 degrees. Special values are defined as:

-9999.9 Missing value

SClongitude (4-byte float, array size: nscan4)

Values range from -180 to 180 degrees. Special values are defined as:

-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan4)

Values range from 0 to 1000 km. Special values are defined as:

-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan4)

The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:

-9999.9 Missing value

Table 3.2-44 SCStatus Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	SCorientation	-9999	0	360	[degree]	2-byte int	2 x nscan4	2	nscan4	1	1
2	SClatitude	-9999.9	-90	90	[degree]	4-byte float	4 x nscan4	4	nscan4	1	1
3	SClongitude	-9999.9	-180	180	[degree]	4-byte float	4 x nscan4	4	nscan4	1	1
4	SCaltitude	-9999.9	0	1000	[km]	4-byte float	4 x nscan4	4	nscan4	1	1
5	FranctionalGranleNumber	-9999.9	0	100000		8-byte float	8 x nscan4	8	nscan4	1	1

(7) Quality (1-byte integer, array size: npixel4 x nscan4)

Quality of Tc in the swath.

GENERAL SPECIFICATIONS
0 = Good data in all channels in the swath
gt 0 = Cautionary warning flags
1-99 = Generic flags (all sensors)
100-127 = Sensor specific flags

lt 0 = Major errors resulting in missing data
-(1-98) = Generic flags (all sensors)
-99 = Missing value (no quality information available)
-(100-127) = Sensor specific flags
DETAILED SPECIFICATIONS
0 = Good data
1 = Possible sun glint
2 = Possible radio frequency interference
3 = Degraded geolocation data
4 = Data corrected for warm load intrusion
-1 = Data is missing from file or unreadable
-2 = Unphysical brightness temperature (Tb lt 50K or 350K gt Tb)
-3 = Error in geolocation data
-4 = Data missing in one channel
-5 = Data missing in multiple channels
-6 = Lat/lon values are out of range
-7 = Non-normal status modes
-10 = Distance to corresponding LF pixel > 7 km
(Used in L1C-R product only)
-99 = Missing value (no quality information available)

Table 3.2-45 Quality Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Quality	-99	-	-	-	1-byte integer	1 x 243 x nscan4	1	npixel4	nscan4	1

(8) incidenceAngle (4-byte float, array size: nchUIA4 x npixel4 x nscan4)

Earth incidence angle. Values range from 0 to 90 degrees. Special values are defined as:

-9999.9 Missing value

Table 3.2-46 incidenceAngle Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	incidenceAngle	-9999.9	0	90	[degree]	4-byte float	4 x 1 x 243 x nscan4	4	nchUIA4	npixel4	nscan4

(9) sunGlintAngle (1-byte integer, array size: nchUIA4 x npixel4 x nscan4)

Sun glint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees. Sun below horizon value is -88.

-99 Missing value

Table 3.2-47 sunGlintAngle Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	sunGlintAngle	-99	0	127	[degree]	4-byte float	4 x 1 x 243 x nscan4	4	nchUIA4	npixel4	nscan4

(10) incidenceAngleIndex (1-byte integer, array size: nchannel1 x nscan4)

Values range from 0 to 100. Special values are defined as:

-99 Missing value

Table 3.2-48 incidenceAngleIndex Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	incidenceAngleIndex	-99	0	100	-	1-byte integer	1 x 2 x nscan4	1	nchannel4	nscan4	1

(11) Tc (4-byte float, array size: nchannel1 x npixel4 x nscan4)

GPM Common Calibrated Brightness Temperature. The channels are:

36.5 GHz vertically-polarized TBs
36.5 GHz horizontally-polarized TBs

Table 3.2-49 Tc Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Tc	-9999.9	0	10000	[K]	4-byte float	4 x 2 x 243 x nscan4	4	nchannel4	npixel4	nscan4

3.2.2.5 S5 (Swath)

(1) S5_SwathHeader (Metadata)

S5_SwathHeader contains metadata for swaths.

Table 3.2-50 S5_SwathHeader Group

Metadata Element	Estimated Size (bytes)	Description
NumberScansInSet	50	The scans read by TKreadScan are a ”set”. For single swath data, one scan is read so NumberScansInSet=1. For multiple swath data, one TKreadScan may read more than one scan. For example, for SSM/I data one TKreadScan reads one low frequency scan and two high frequency scans. Therefore NumberScansInSet=1 for the low frequency swath and NumberScansInSet=2 for the high frequency swath.
MaximumNumberScansTotal	50	The maximum allowed number of total scans in this swath. Total scans = overlap scans before granule + scans in granule + overlap scans after granule.
NumberScansBeforeGranule	50	The number of overlap scans before the first scan of the granule in this swath.
NumberScansGrAnule	50	The number of scans in the granule in this swath.
NumberScansAfterGranule	50	The number of overlap scans after the last scan of the granule in this swath.
NumberPixels	50	The number of IFOV in each scan in this swath.
ScanType	50	The type of scan in this swath. Values are: ”CROSSTRACK” and ”CONICAL”

(2) S5_IncidenceAngleIndex (Metadata)

S5_IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array.

Table 3.2-51 S5_IncidenceAngleIndex Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	S5_IncidenceAngleIndex	-99	0	100	-	1-byte integer	1 x 2 x nscan5	1	nchannel5	nscan5	1

(3) ScanTime (Group in S5)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan5)

4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:

-9999 Missing value

Month (1-byte integer, array size: nscan5)

Month of the year. Values range from 1 to 12 months. Special values are defined as:

-99 Missing value

DayOfMonth (1-byte integer, array size: nscan5)

Day of the month. Values range from 1 to 31 days. Special values are defined as:

-99 Missing value

Hour (1-byte integer, array size: nscan5)

UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:

-99 Missing value

Minute (1-byte integer, array size: nscan5)

Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:

-99 Missing value

Second (1-byte integer, array size: nscan5)

Second of the minute. Values range from 0 to 60 s. Special values are defined as:

-99 Missing value

MilliSecond (2-byte integer, array size: nscan5)

Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:

-9999 Missing value

DayOfYear (2-byte integer, array size: nscan5)

Day of the year. Values range from 1 to 366 days. Special values are defined as:

-9999 Missing value

SecondOfDay (8-byte float, array size: nscan5)

A time associated with the scan. scanTime sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:

-9999.9 Missing value

Table 3.2-52 ScanTime Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Year	-9999	1950	2100	[year]	2-byte int	2 x nscan5	2	nscan5	1	1
2	Month	-99	1	12	[month]	1-byte integer	1 x nscan5	1	nscan5	1	1
3	DayOFMonth	-99	1	31	[day]	1-byte integer	1 x nscan5	1	nscan5	1	1
4	Hour	-99	0	23	[hour]	1-byte integer	1 x nscan5	1	nscan5	1	1
5	Minute	-99	0	59	[minute]	1-byte integer	1 x nscan5	1	nscan5	1	1
6	Second	-99	0	60	[s]	1-byte integer	1 x nscan5	1	nscan5	1	1
7	MilliSecond	-9999	0	999	[ms]	2-byte int	2 x nscan5	2	nscan5	1	1
8	DayOfYear	-9999	1	366	[day]	2-byte int	2 x nscan5	2	nscan5	1	1
9	SecoundOfDay	-9999.9	0	86400	[s]	8-byte float	8 x nscan5	8	nscan5	1	1

(4) Latitude (4-byte float, array size: npixel5 x nscan5)

The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:

-9999.9 Missing value

Table 3.2-53 Latitude Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Latitude	-9999.9	-90	90	[degree]	4-byte float	4 x 486 x nscan5	4	npixel5	nscan5	1

(5) Longitude (4-byte float, array size: npixel5 x nscan5)

The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:

-9999.9 Missing value

Table 3.2-54 Longitude Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Longitude	-9999.9	-180	180	[degree]	4-byte float	4 x 486 x nscan5	4	npixel5	nscan5	1

(6) SCstatus (Group in S5)

SCorientation (2-byte integer, array size: nscan5)

The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:

-9999 Missing value

SClatitude (4-byte float, array size: nscan5)

Values range from -90 to 90 degrees. Special values are defined as:

-9999.9 Missing value

SClongitude (4-byte float, array size: nscan5)

Values range from -180 to 180 degrees. Special values are defined as:

-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan5)

Values range from 0 to 1000 km. Special values are defined as:

-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan5)

The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:

-9999.9 Missing value

Table 3.2-55 SCStatus Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	SCorientation	-9999	0	360	[degree]	2-byte int	2 x nscan5	2	nscan5	1	1
2	SClatitude	-9999.9	-90	90	[degree]	4-byte float	4 x nscan5	4	nscan5	1	1
3	SClongitude	-9999.9	-180	180	[degree]	4-byte float	4 x nscan5	4	nscan5	1	1
4	SCaltitude	-9999.9	0	1000	[km]	4-byte float	4 x nscan5	4	nscan5	1	1
5	FranctionalGranleNumber	-9999.9	0	100000		8-byte float	8 x nscan5	8	nscan5	1	1

(7) Quality (1-byte integer, array size: npixel5 x nscan5)

Quality of Tc in the swath.

GENERAL SPECIFICATIONS
0 = Good data in all channels in the swath
gt 0 = Cautionary warning flags
1-99 = Generic flags (all sensors)
100-127 = Sensor specific flags
lt 0 = Major errors resulting in missing data
-(1-98) = Generic flags (all sensors)
-99 = Missing value (no quality information available)
-(100-127) = Sensor specific flags

DETAILED SPECIFICATIONS
0 = Good data
1 = Possible sun glint
2 = Possible radio frequency interference
3 = Degraded geolocation data
4 = Data corrected for warm load intrusion
-1 = Data is missing from file or unreadable
-2 = Unphysical brightness temperature (Tb lt 50K or 350K gt Tb)
-3 = Error in geolocation data
-4 = Data missing in one channel
-5 = Data missing in multiple channels
-6 = Lat/lon values are out of range
-7 = Non-normal status modes
-10 = Distance to corresponding LF pixel > 7 km
(Used in L1C-R product only)
-99 = Missing value (no quality information available)

Table 3.2-56 Quality Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Quality	-99	-	-	-	1-byte integer	1 x 486 x nscan5	1	npixel5	nscan5	1

(8) incidenceAngle (4-byte float, array size: nchUIA5 x npixel5 x nscan5)

Earth incidence angle. Values range from 0 to 90 degrees. Special values are defined as:

-9999.9 Missing value

Table 3.2-57 incidenceAngle Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	incidenceAngle	-9999.9	0	90	[degree]	4-byte float	4 x 1 x 486 x nscan5	4	nchUIA5	npixel5	nscan5

(9) sunGlintAngle (1-byte integer, array size: nchUIA5 x npixel5 x nscan5)

Sunglint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees. Sun below horizon value is -88.

-99 Missing

Table 3.2-58 sunGlintAngle Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	sunGlintAngle	-99	0	127	[degree]	4-byte float	4 x 1 x 486 x nscan5	4	nchUIA5	npixel5	nscan5

(10) incidenceAngleIndex (1-byte integer, array size: nchannel5 x nscan5)

Values range from 0 to 100. Special values are defined as:

-99 Missing value

Table 3.2-59 incidenceAngleIndex Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	incidenceAngleIndex	-99	0	100	-	1-byte integer	1 x 2 x nscan5	1	nchannel5	nscan5	1

(11) Tc (4-byte float, array size: nchannel5 x npixel5 x nscan5)

GPM Common Calibrated Brightness Temperature. The channels are:

89 GHz vertically-polarized TBs

89 GHz horizontally-polarized TBs

Table 3.2-60 Tc Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Tc	-9999.9	0	10000	[K]	4-byte float	4 x 2 x 486 x nscan5	4	nchannel5	npixel5	nscan5

3.2.2.6 S6 (Swath)

(1) S6_SwathHeader (Metadata)

S6_SwathHeader contains metadata for swaths.

Table 3.2-61 S6_SwathHeader Group

Metadata Element	Estimated Size (bytes)	Description
NumberScansInSet	50	The scans read by TKreadScan are a ”set”. For single swath data, one scan is read so NumberScansInSet=1. For multiple swath data, one TKreadScan may read more than one scan. For example, for SSM/I data one TKreadScan reads one low frequency scan and two high frequency scans. Therefore NumberScansInSet=1 for the low frequency swath and NumberScansInSet=2 for the high frequency swath.
MaximumNumberScansTotal	50	The maximum allowed number of total scans in this swath. Total scans = overlap scans before granule + scans in granule + overlap scans after granule.
NumberScansBeforeGranule	50	The number of overlap scans before the first scan of the granule in this swath.
NumberScansGrAnule	50	The number of scans in the granule in this swath.
NumberScansAfterGranule	50	The number of overlap scans after the last scan of the granule in this swath.
NumberPixels	50	The number of IFOV in each scan in this swath.
ScanType	50	The type of scan in this swath. Values are: ”CROSSTRACK” and ”CONICAL”

(2) S6_IncidenceAngleIndex (Metadata)

S6_IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array.

Table 3.2-62 S6_IncidenceAngleIndex Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	S6_IncidenceAngleIndex	-99	0	100	-	1-byte integer	1 x 2 x nscan6	1	nchannel6	nscan6	1

(3) ScanTime (Group in S6)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan6)

4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:

-9999 Missing value

Month (1-byte integer, array size: nscan6)

Month of the year. Values range from 1 to 12 months. Special values are defined as:

-99 Missing value

DayOfMonth (1-byte integer, array size: nscan6)

Day of the month. Values range from 1 to 31 days. Special values are defined as:

-99 Missing value

Hour (1-byte integer, array size: nscan6)

UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:

-99 Missing value

Minute (1-byte integer, array size: nscan6)

Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:

-99 Missing value

Second (1-byte integer, array size: nscan6)

Second of the minute. Values range from 0 to 60 s. Special values are defined as:

-99 Missing value

MilliSecond (2-byte integer, array size: nscan6)

Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:

-9999 Missing value

DayOfYear (2-byte integer, array size: nscan6)

Day of the year. Values range from 1 to 366 days. Special values are defined as:

-9999 Missing value

SecondOfDay (8-byte float, array size: nscan6)

A time associated with the scan. scanTime sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:

-9999.9 Missing value

Table 3.2-63 ScanTime Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Year	-9999	1950	2100	[year]	2-byte int	2 x nscan6	2	nscan6	1	1
2	Month	-99	1	12	[month]	1-byte integer	1 x nscan6	1	nscan6	1	1
3	DayOFMonth	-99	1	31	[day]	1-byte integer	1 x nscan6	1	nscan6	1	1
4	Hour	-99	0	23	[hour]	1-byte integer	1 x nscan6	1	nscan6	1	1
5	Minute	-99	0	59	[minute]	1-byte integer	1 x nscan6	1	nscan6	1	1
6	Second	-99	0	60	[s]	1-byte integer	1 x nscan6	1	nscan6	1	1
7	MilliSecond	-9999	0	999	[ms]	2-byte int	2 x nscan6	2	nscan6	1	1
8	DayOfYear	-9999	1	366	[day]	2-byte int	2 x nscan6	2	nscan6	1	1
9	SecoundOfDay	-9999.9	0	86400	[s]	8-byte float	8 x nscan6	8	nscan6	1	1

(4) Latitude (4-byte float, array size: npixel6 x nscan6)

The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:

-9999.9 Missing value

Table 3.2-64 Latitude Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Latitude	-9999.9	-90	90	[degree]	4-byte float	4 x 486 x nscan6	4	npixel6	nscan6	1

(5) Longitude (4-byte float, array size: npixel6 x nscan6)

The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:

-9999.9 Missing value

Table 3.2-65 Longitude Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Longitude	-9999.9	-180	180	[degree]	4-byte float	4 x 486 x nscan6	4	npixel6	nscan6	1

(6) SCstatus (Group in S6)

SCorientation (2-byte integer, array size: nscan6)

The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:

-9999 Missing value

SClatitude (4-byte float, array size: nscan6)

Values range from -90 to 90 degrees. Special values are defined as:

-9999.9 Missing value

SClongitude (4-byte float, array size: nscan6)

Values range from -180 to 180 degrees. Special values are defined as:

-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan6)

Values range from 0 to 1000 km. Special values are defined as:

-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan6)

The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:

-9999.9 Missing value

Table 23.2-66 SCStatus Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	SCorientation	-9999	0	360	[degree]	2-byte int	2 x nscan6	2	nscan6	1	1
2	SClatitude	-9999.9	-90	90	[degree]	4-byte float	4 x nscan6	4	nscan6	1	1
3	SClongitude	-9999.9	-180	180	[degree]	4-byte float	4 x nscan6	4	nscan6	1	1
4	SCaltitude	-9999.9	0	1000	[km]	4-byte float	4 x nscan6	4	nscan6	1	1
5	FranctionalGranleNumber	-9999.9	0	100000		8-byte float	8 x nscan6	8	nscan6	1	1

(7) Quality (1-byte integer, array size: npixel6 x nscan6)

Quality of Tc in the swath.

GENERAL SPECIFICATIONS
0 = Good data in all channels in the swath
gt 0 = Cautionary warning flags
1-99 = Generic flags (all sensors)
100-127 = Sensor specific flags
lt 0 = Major errors resulting in missing data
-(1-98) = Generic flags (all sensors)
-99 = Missing value (no quality information available)
-(100-127) = Sensor specific flags
DETAILED SPECIFICATIONS
0 = Good data
1 = Possible sun glint
2 = Possible radio frequency interference
3 = Degraded geolocation data
4 = Data corrected for warm load intrusion
-1 = Data is missing from file or unreadable
-2 = Unphysical brightness temperature (Tb lt 50K or 350K gt Tb)
-3 = Error in geolocation data
-4 = Data missing in one channel
-5 = Data missing in multiple channels
-6 = Lat/lon values are out of range
-7 = Non-normal status modes
-10 = Distance to corresponding LF pixel > 7 km
(Used in L1C-R product only)
-99 = Missing value (no quality information available)

Table 3.2-67 Quality Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Quality	-99	-	-	-	1-byte integer	1 x 486 x nscan6	1	npixel6	nscan6	1

(8) incidenceAngle (4-byte float, array size: nchUIA6 x npixel6 x nscan6)

Earth incidence angle. Values range from 0 to 90 degrees. Special values are defined as:

-9999.9 Missing value

Table 3.2-68 incidenceAngle Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	incidenceAngle	-9999.9	0	90	[degree]	4-byte float	4 x 1 x 486 x nscan6	4	nchUIA6	npixel6	nscan6

(9) sunGlintAngle (1-byte integer, array size: nchUIA6 x npixel6 x nscan6)

Sun glint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees. Sun below horizon value is -88.

-99 Missing value

Table 3.2-69 sunGlintAngle Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	sunGlintAngle	-99	0	127	[degree]	4-byte float	4 x 1 x 486 x nscan6	4	nchUIA6	npixel6	nscan6

(10) incidenceAngleIndex (1-byte integer, array size: nchannel6 x nscan6)

Values range from 0 to 100. Special values are defined as:

-99 Missing value

Table 3.2-70 incidenceAngleIndex Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	incidenceAngleIndex	-99	0	100	-	1-byte integer	1 x 2 x nscan6	1	nchannel6	nscan6	1

(11) Tc (4-byte float, array size: nchannel6 x npixel6 x nscan6)

GPM Common Calibrated Brightness Temperature. The channels are:

89 GHz vertically-polarized TBs
89 GHz horizontally-polarized TBs

Table 3.2-71 Tc Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Tc	-9999.9	0	10000	[K]	4-byte float	4 x 2 x 486 x nscan6	4	nchannel6	npixel6	nscan6

4. 1CSSMIS – Common Calibrated Brightness Temperature

4.1. Data Format Structure

4.1.1. Dimension definition

Dimension definitions:

- nscan1
  - var Number of Swath S1 scans in the granule.
- nchannel1
  - 3 Number of Swath S1 channels.
- npixel1
  - 90 Number of Swath S1 pixels in one scan.
- nchUIA1
  - 1 Number of Swath S1 unique incidence angles.
- nscan2
  - var Number of Swath S2 scans in the granule.
- nchannel2
  - 2 Number of Swath S2 channels.
- npixel2
  - 90 Number of Swath S2 pixels in one scan.
- nchUIA2
  - 1 Number of Swath S2 unique incidence angles.
- nscan3
  - var Number of Swath S3 scans in the granule.
- nchannel3
  - 4 Number of Swath S3 channels.
- npixel3
  - 180 Number of Swath S3 pixels in one scan.
- nchUIA3
  - 1 Number of Swath S3 unique incidence angles.
- nscan4
  - var Number of Swath S4 scans in the granule.
- nchannel4
  - 2 Number of Swath S4 channels.
- npixel4
  - 180 Number of Swath S4 pixels in one scan.
- nchUIA4
  - 1 Number of Swath S4 unique incidence angles.

4.1.2. Data Format Structure for 1CSSMIS – Common Calibrated Brightness Temperature

1CSSMIS contains common calibrated brightness temperature from the SSMIS passive microwave instruments flown on the DMSP satellites. Swath S1 has 3 low frequency channels (19V 19H 22V). Swath S2 has 2 low frequency channels (37V 37H). Swath S3 has 4 high frequency channels (150H 183+/-1H 183+/-3H 183+/-7H). S4 has 2 high frequency channels (91V 91H). All the above frequencies are in GHz.

Earth observations for all four swaths are taken during a 144^{o} segment of the instrument rotation when SSMIS scans in the direction of forward satellite motion. We define the spacecraft vector (v) at the center of this segment. ”v” is used in the definition of the variable SCorientation.

RELATION BETWEEN THE SWATHS: Each S1 and S2 scan contains low frequency channels sampled 90 times along the scan. Each S3 and S4 scan contains high frequency channels sampled 180 times along the scan. All four swaths have exactly the same number of scans. All four swaths repeat scans every 1.9s. The earth positions of S1 are very close to those of S2. The earth positions of S3 are very close to those of S4. The earth positions of S1 and S2 alternate with those of S3 and S4 along the satellite track. The positions of the S1 and S2 pixels do not match the positions of the S3 and S4 pixels.

The Figure below shows the locations of the samples of Swath S1 and Swath S2 scan 1 and Swath S3 and Swath S4 scan 1. Each ”+” represents centers of samples from two swaths. For example, the label ”S1S2:1,2” means that Swath S1 and Swath S2, scan 1, sample 2 is located approximately at the ”+”. The positions of S1 and S2 are slightly different from each other but close enough to be represented by the same ”+” in the Figure. The positions of S3 and S4 are slightly different from each other but close enough to be represented by the same ”+” in the Figure.

S1S2:1, 1		S1S2:1, 2			S1S2:1, 90
+		+	…..		+
S3S4:1, 1	S3S4:1, 2	S3S41, 3		S3S41, 179	S3S4:1, 180
+	+	+	…..	+	+

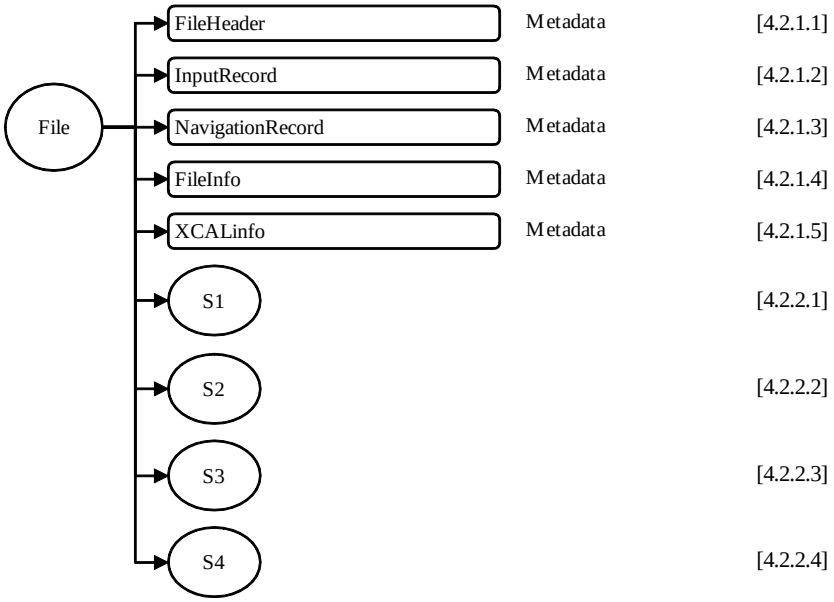

Figure 4.1-1 Data Format Structure for 1CSSMIS – Common Calibrated Brightness Temperature

4.1.3. Data Format Structure for each Group

4.1.3.1 Data Format Structure for S1 Group

S1 Group's structure is shown in this section.

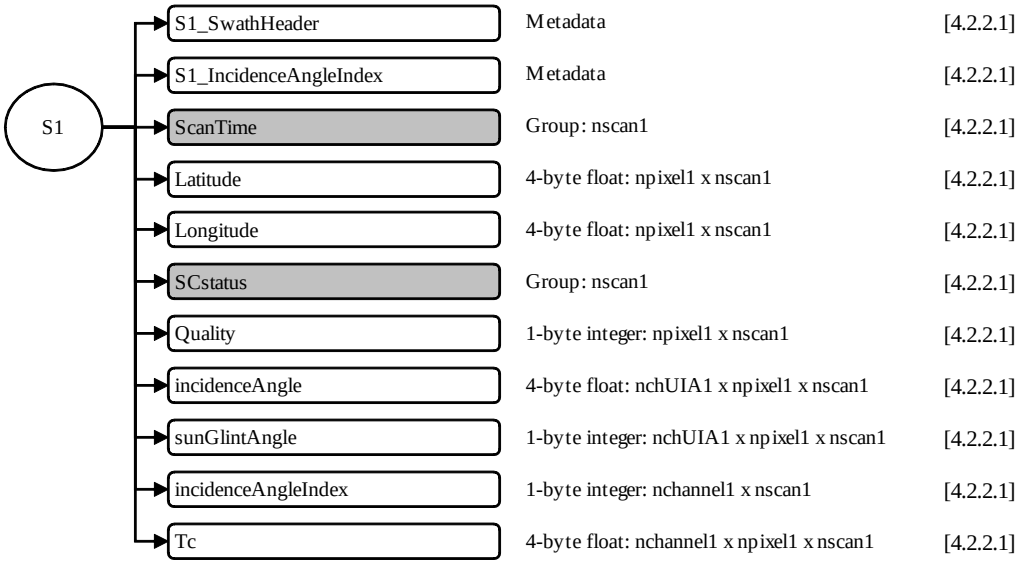

Figure 4.1-2 Data Format Structure for 1CSSMIS, S1

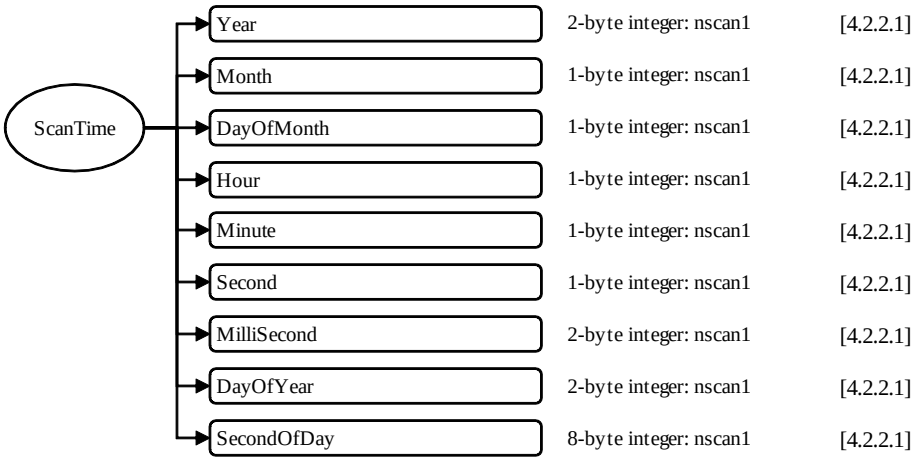

Figure 4.1-3 Data Format Structure for 1CSSMIS, ScanTime

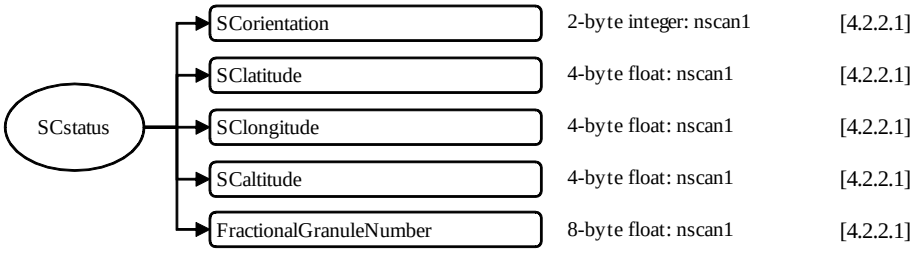

Figure 4.1-4 Data Format Structure for 1CSSMIS, SCstatus

4.1.3.2 Data Format Structure for S2 Group

S2 Group's structure is shown in this section.

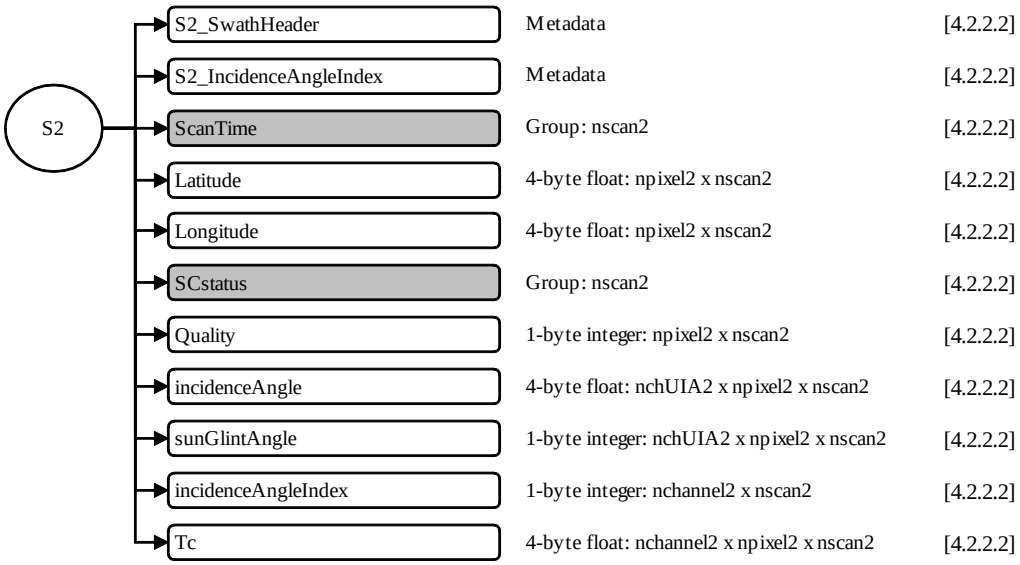

Figure 4.1-5 Data Format Structure for 1CSSMIS, S2

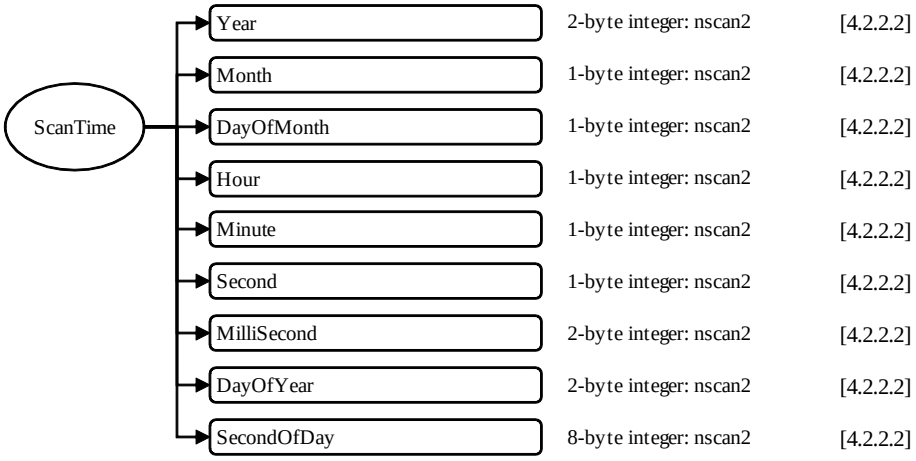

Figure 4.1-6 Data Format Structure for 1CSSMIS, S2, ScanTime

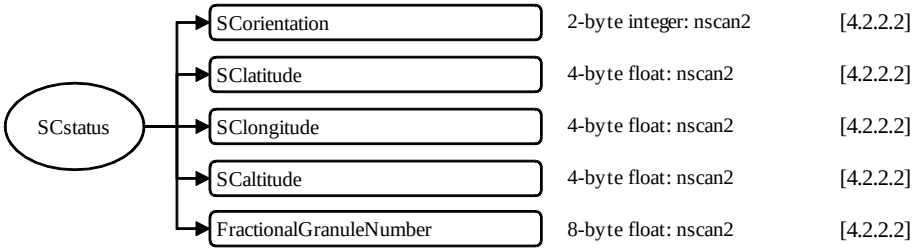

Figure 4.1-7 Data Format Structure for 1CSSMIS, S2, SCstatus

4.1.3.3 Data Format Structure for S3 Group

S3 Group's structure is shown in this section.

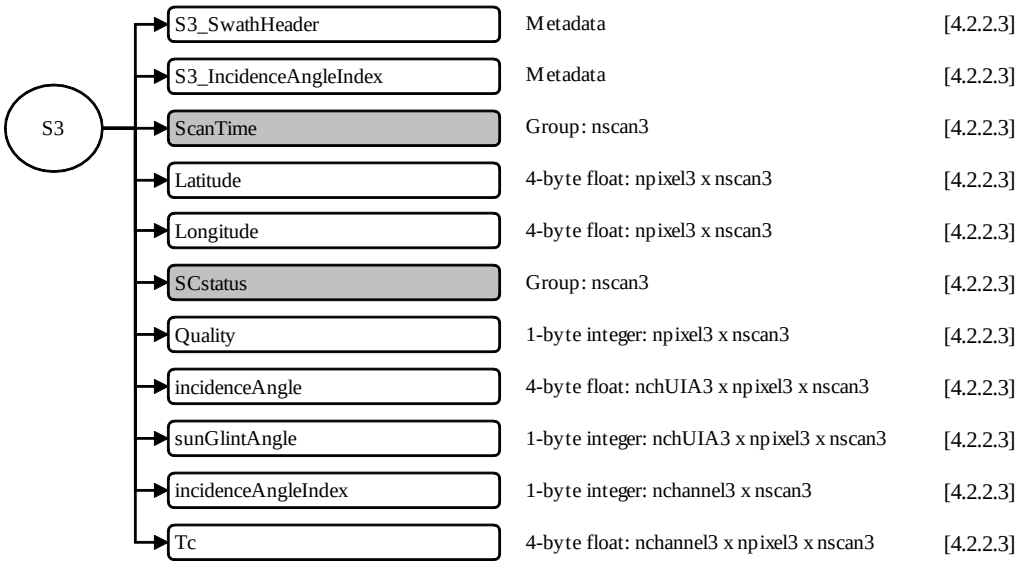

Figure 4.1-8 Data Format Structure for 1CSSMIS, S3

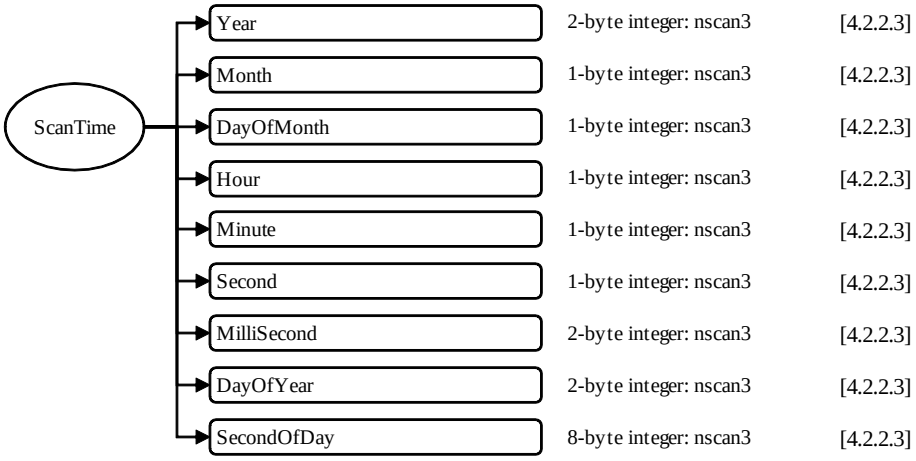

Figure 4.1-9 Data Format Structure for 1CSSMIS, S3, ScanTime

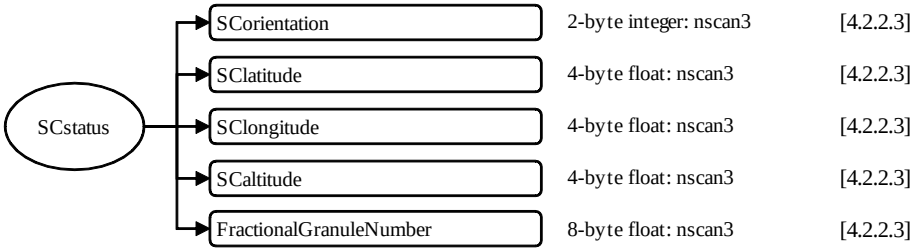

Figure 4.1-10 Data Format Structure for 1CSSMIS, S3, SCstatus

4.1.3.4 Data Format Structure for S4 Group

S4 Group's structure is shown in this section.

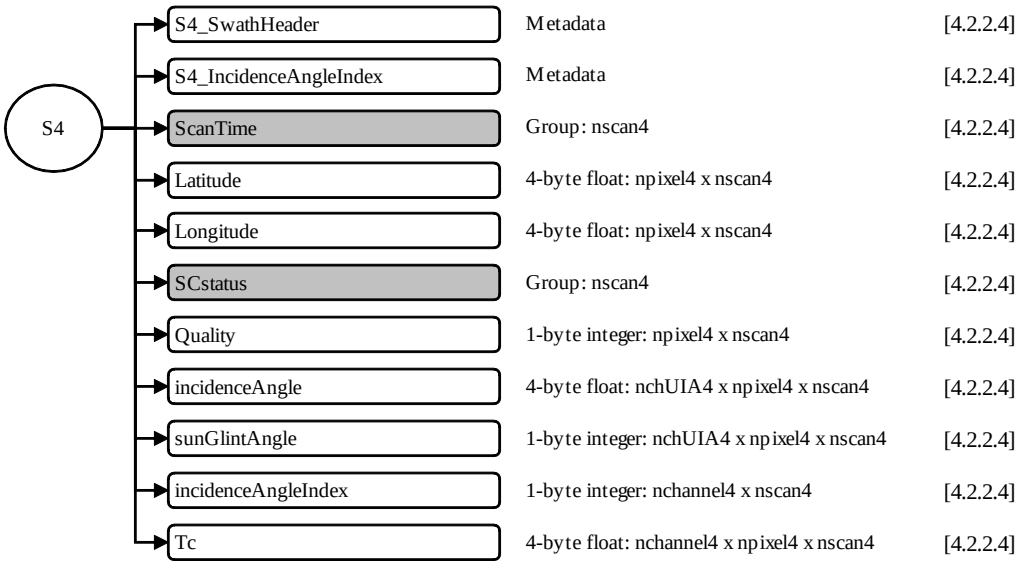

Figure 4.1-11 Data Format Structure for 1CSSMIS, S4

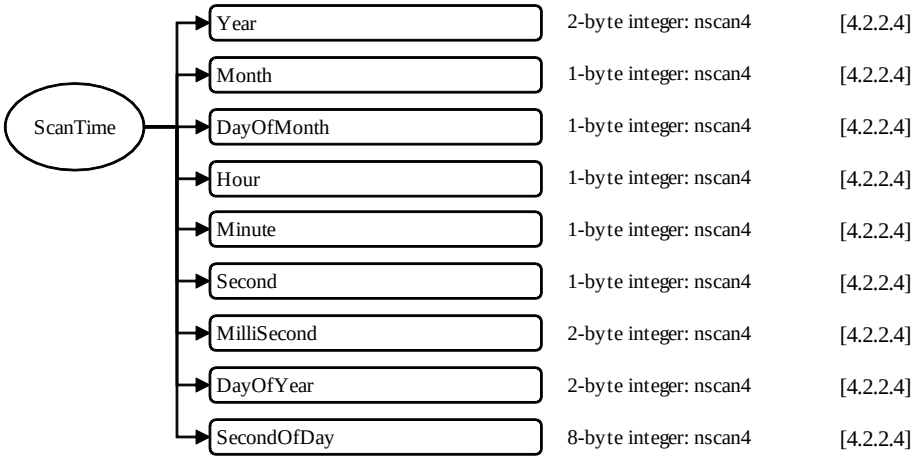

Figure 4.1-12 Data Format Structure for 1CSSMIS, S4, ScanTime

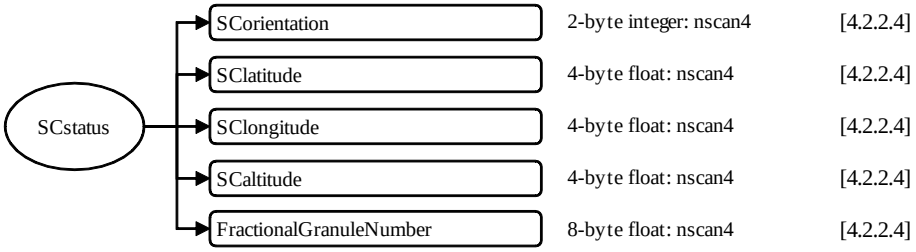

Figure 4.1-13 Data Format Structure for 1CSSMIS, S4, SCstatus

4.2. Contents of objects in each Group

4.2.1. Metadata

4.2.1.1 FileHeader

FileHeader contains metadata of general interest. Table 4.2-1 shows each metadata elements in FileHeader.

Table 4.2-1 FileHeader Group

Metadata Element	Estimated Size (bytes)	Description
DOI	256	Digital Object Identifier *Value is blank currently
DOIauthority	256	Digital Object Identifier Authority.
DOIshortName	256	Digital Object Identifier Short Name. *Value is blank currently.
AlgorithmID	50	The algorithm that generated this product, e.g., 2A12.
AlgorithmVersion	50	The version of the algorithm that generated this product.
FileName	50	The file name of this granule.
SatelliteName	10	Values are: TRMM GPM MULTI F10 ... F18 AQUA GCOMW1 CORIOLIS MT1 NOAA15 ... NOAA19 METOPANPP. More values will be added as they are known.
InstrumentName	10	Values are: PR TMI VIRS PRTMI KU KA DPR GMI DPRGMI MERGED SSMI SSMIS AMSRE AMSR2 WIND-SAT MADRAS AMSUA AMSUB SAPHIR MHS ATMS. More values will be added as they are known.
GenerationDateTime	50	The date and time this granule was generated. The format is YYYY-MM-DDTHH:MM:SS.sssZ, where YYYY is 4-digit year, MM is month number, DD is day of month, T is ”T”, HH is hour, MM is minute, SS is second, sss is millisecond, and Z is ”Z”. All fields are zero-filled. The missing value is constructed by replacing all digits with 9, i.e., 9999-99-99T99:99:99.999Z
StartGranuleDateTime	50	The start time defining this granule. The format is the same as GenerationDateTime. DETAILS: An orbital granule starts when the satellite is at the position defined by GranuleStart. Thus the start time is not the first scan time. Some algorithms have overlap scans in the file before the start time as defined in SwathHeader. A monthly granule starts on the first ms of the month, for example March 1998 would be 1998-03-01T00:00:00.000Z
StopGranuleDateTime	50	The stop time defining this granule. The format is the same as GenerationDateTime. DETAILS: An orbital granule stops when the satellite is at the position defined by GranuleStart. Thus the stop time is not the last scan time. Some algorithms have overlap scans in the file after the stop time as defined in SwathHeader. A monthly granule stops on the last ms of the month, for example March 1998 would be 1998-03-31T23:59:59.999Z
GranuleNumber	50	The number of this granule, which starts as in GranuleStart. If the GranuleStart is identical to the orbit start, then the GranuleNumber will be the same as the orbit number. The GranuleNumber will have 6 digits, including leading zeroes, for example 001234.
NumberOfSwaths	50	The number of swaths in this granule.
NumberOfGrids	50	The number of grid structures in this granule.
GranuleStart	50	The starting place in the orbit of this granule. Currently defined values are ”SOUTHERNMOST LATITUDE” and ”NORTHBOUND EQUATOR CROSSING”.
TimeInterval	50	The time interval covered by this granule. Values are ”ORBIT”, ”HALF ORBIT”, ”HALF HOUR”, ”HOUR”, ”3 HOUR”, ”DAY”, ”MONTH”, ”CONTACT”.

Metadata Element	Estimated Size (bytes)	Description
ProcessingSystem	50	The name of the processing system, e.g., ”PPS”, ”JAXA”.
ProductVersion	50	The data version assigned by the processing system.
EmptyGranule	50	Whether a granule is empty. Values are ”EMPTY” or ”NOT EMPTY”.
MissingData	50	The number of missing scans.

4.2.1.2 InputRecord

InputRecord contains a record of input files for this granule. Table 4.2-2 shows each metadata elements in InputRecord.

Table 4.2-2 InputRecord Group

Metadata Element	Estimated Size (bytes)	Description
InputFileName	1000	A list of input file names for this granule.
InputAlgorithmVersions	1000	A list of algorithm versions of the input files for this granule.
InputGenerationDatteTimes	1000	A list of generation date times of the input files for this granule. The format is the same as GenerationDateTime.

4.2.1.3 NavigationRecord

NavigationRecord contains navigation metadata for this granule. Table 4.2-3 shows each metadata elements in NavigationRecord.

Table 4.2-3 NavigationRecord Group

Metadata Element	Estimated Size (bytes)	Description
LongitudeOnEquator	50	The longitude where the satellite crosses the equator going from south to north.
UTCDateTimeOnEquator	50	The UTC time when the satellite crosses the equator going from south to north. The format is the same as GenerationDate Time.
MeanSolarBetaAngle	50	The average solar beta angle in this granule.
EphemerisFileName	50	Name of the ephemeris file input for processing.
AttitudeFileName	50	Name of the attitude file input for processing.
GeoControlFileName	50	Name of the GeoTK Control Parameters File input for processing.
EphemerisSource	50	Values are ”0 CONSTANT INPUT TEST VALUE”, ”1 GROUND ESTIMATED STATE (GES)”, ”2 GPS FILTERED SOLUTION (GEONS)”, ”3 GPS POINT SOLUTION (PVT)”, ”4 ON BOARD PROPAGATED (OBP)”, ”5 OEM GROUND EPHEMERIS FILE”, ”6 GEONS WITH FALLBACK AS FLAGGED”, ”7 PVT WITH FALLBACK AS FLAGGED”, ”8 OBP WITH FALLBACK AS FLAGGED”, ”9 GES WITH FALLBACK AS FLAGGED”
AttitudeSource	50	Values are ”0 CONSTANT INPUTS FOR TESTING”, ”1 ON BOARD CALCULATED PITCH ROLL YAW”
GeoToolkitVersion	50	Version of the GeoToolkit
SensorAlignmentFirstRotationAngle	50	Alignment angle, first rotation, in degrees. Rotation adjustment from sensor coordinates to the Attitude Control System Flight Coordinates.
SensorAlignmentSecondRotationAngle	50	Alignment angle, second rotation, in degrees.
SensorAlignmentThirdRotationAngle	50	Alignment angle, third rotation, in degrees.

Metadata Element	Estimated Size (bytes)	Description
SensorAlignmentFirstRotationAxis	50	Euler rotation sequence, first rotation axis. Values are ”1”, ”2”, ”3” (representing X, Y, Z).
SensorAlignmentSecondRotationAxis	50	Euler rotation sequence, second rotation axis. Values are ”1”, ”2”, ”3” (representing X, Y, Z).
SensorAlignmentThirdRotationAxis	50	Euler rotation sequence, third rotation axis. Values are ”1”, ”2”, ”3” (representing X, Y, Z).

4.2.1.4 FileInfo

FileInfo contains metadata used by the PPS I/O Toolkit. Table 4.2-4 shows each metadata elements in FileInfo.

Table 4.2-4 FileInfo Group

Metadata Element	Estimated Size (bytes)	Description
DataFormatVersion	50	The version of the data format used to write this file. This version is separate for each AlgorithmID. The order is: ”a” ”b” ... ”z” ”aa” ”ab” ... ”az” ”ba” ”bb” ...
TKCodeBuildVersion	50	Usually TK CodeBuildVersion is ”1”. If the I/O routines built by TKIO change even though the DataFormatVersion is unchanged, then TK CodeBuildVersion increments to ”2”, ”3”, ... If subsequently DataFormatVersion changes, TKCodeBuildVersion becomes ”1” again.
MetadataVersion	50	The version of metadata used to write this file. This version is separate for each AlgorithmID. The order is: ”a” ”b” ... ”z” ”aa” ”ab” ... ”az” ”ba” ”bb” ...
FormatPackage	50	The underlying format of this granule. Values are ”HDF4”, ”HDF5”, ”NETCDF”, ”TKBINARY”
BlueprintFilename	50	The filename of the primary blueprint file that defined the format used to write this file.
BlueprintVersion	10	The BlueprintVersion of the format definition
TKIOVersion	50	The version of TKIO used to create I/O routines to write this file. TKIOVersion does not define the format used to write this file.
MetadataStyle	50	The style in which the metadata was written, e.g., ”PVL”. ”PVL” means < parameter >=< value >;
EndianType	50	The endian type of the system that wrote this file. Values are ”BIG ENDIAN” and ”LITTLE ENDIAN”.

4.2.1.5 XCALinfo

XCALinfo contains metadata required by 1C intercalibrated files.

Table 4.2-5 XCALinfo Group

Metadata Element	Estimated Size (bytes)	Description
CalibrationStandard	50	The brightness temperature reference standard, e.g., ”cc 1.1”.
CalibrationTable	50	The name of a file containing the calibration table used to make this product, e.g., ”1C.AQUA.ASMRE.XCAL2013-P.tbl”.
CalibrationLevel	50	The level development of the intercalibration for a given sensor. When this level increases for a given sensor the Level 1C files are reprocessed and the version number will also increment. The intercalibration level is defined as follows: N (None): No intercalibration has been applied. Tbs are unchanged from Level 1B source files.

Metadata Element	Estimated Size (bytes)	Description
		P (Preliminary): A preliminary or beta intercalibration has been applied to match the Tb to the reference. V (Verified): The intercalibration has been verified by at least one independent effort. C (Consensus): The XCAL intercalibration has been finalized and accepted by the Science Team.

4.2.2. Data Group

Elements of data group are explained in detail in this section.

4.2.2.1 S1 (Swath)

(1) S1_SwathHeader (Metadata)

S1_SwathHeader contains metadata for swaths.

Table 4.2-6 S1_SwathHeader Group

Metadata Element	Estimated Size (bytes)	Description
NumberScansInSet	50	The scans read by TKreadScan are a ”set”. For single swath data, one scan is read so NumberScansInSet=1. For multiple swath data, one TKreadScan may read more than one scan. For example, for SSM/I data one TKreadScan reads one low frequency scan and two high frequency scans. Therefore NumberScansInSet=1 for the low frequency swath and NumberScansInSet=2 for the high frequency swath.
MaximumNumberScansTotal	50	The maximum allowed number of total scans in this swath. Total scans = overlap scans before granule + scans in granule + overlap scans after granule.
NumberScansBeforeGranule	50	The number of overlap scans before the first scan of the granule in this swath.
NumberScansGranule	50	The number of scans in the granule in this swath.
NumberScansAfterGranule	50	The number of overlap scans after the last scan of the granule in this swath.
NumberPixels	50	The number of IFOV in each scan in this swath.
ScanType	50	The type of scan in this swath. Values are: ”CROSSTRACK” and ”CONICAL”

(2) S1_IncidenceAngleIndex (Metadata)

S1_IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array.

Table 4.2-7 S1_IncidenceAngleIndex Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	S1_IncidenceAngleIndex	-99	0	100	-	1-byte integer	1 x 3 x nscan1	1	nchannel1	nscan1	1

(3) ScanTime (Group in S1)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan1)

4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:

-9999 Missing value

Month (1-byte integer, array size: nscan1)

Month of the year. Values range from 1 to 12 months. Special values are defined as:

-99 Missing value

DayOfMonth (1-byte integer, array size: nscan1)

Day of the month. Values range from 1 to 31 days. Special values are defined as:

-99 Missing value

Hour (1-byte integer, array size: nscan1)

UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:

-99 Missing value

Minute (1-byte integer, array size: nscan1)

Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:

-99 Missing value

Second (1-byte integer, array size: nscan1)

Second of the minute. Values range from 0 to 60 s. Special values are defined as:

-99 Missing value

MilliSecond (2-byte integer, array size: nscan1)

Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:

-9999 Missing value

DayOfYear (2-byte integer, array size: nscan1)

Day of the year. Values range from 1 to 366 days. Special values are defined as:

-9999 Missing value

SecondOfDay (8-byte float, array size: nscan1)

A time associated with the scan. scanTime sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:

-9999.9 Missing value

Table 4.2-8 ScanTime Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Year	-9999	1950	2100	[year]	2-byte integer	2 x nscan1	2	nscan1	1	1
2	Month	-99	1	12	[month]	1-byte integer	1 x nscan1	1	nscan1	1	1
3	DayOFMonth	-99	1	31	[day]	1-byte integer	1 x nscan1	1	nscan1	1	1
4	Hour	-99	0	23	[hour]	1-byte integer	1 x nscan1	1	nscan1	1	1
5	Minute	-99	0	59	[minute]	1-byte integer	1 x nscan1	1	nscan1	1	1
6	Second	-99	0	60	[s]	1-byte integer	1 x nscan1	1	nscan1	1	1
7	MilliSecond	-9999	0	999	[ms]	2-byte integer	2 x nscan1	2	nscan1	1	1
8	DayOfYear	-9999	1	366	[day]	2-byte integer	2 x nscan1	2	nscan1	1	1
9	SecoundOfDay	-9999.9	0	86400	[s]	8-byte float	8 x nscan1	8	nscan1	1	1

(4) Latitude (4-byte float, array size: npixel1 x nscan1)

The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:

-9999.9 Missing value

Table 4.2-9 Latitude Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Latitude	-9999.9	-90	90	[degree]	4-byte float	4 x 90 x nscan1	4	npixel1	nscan1	1

(5) Longitude (4-byte float, array size: npixel1 x nscan1)

The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:

-9999.9 Missing value

Table 4.2-10 Longitude Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Longitude	-9999.9	-180	180	[degree]	4-byte float	4 x 90 x nscan1	4	npixel1	nscan1	1

(6) SCstatus (Group in S1)

SCorientation (2-byte integer, array size: nscan1)

The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:

-9999 Missing value

SClatitude (4-byte float, array size: nscan1)

Values range from -90 to 90 degrees. Special values are defined as:

-9999.9 Missing value

SClongitude (4-byte float, array size: nscan1)

Values range from -180 to 180 degrees. Special values are defined as:

-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan1)

Values range from 0 to 1000 km. Special values are defined as:

-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan1)

The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:

-9999.9 Missing value

Table 4.2-11 SCStatus Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	SCorientation	-9999	0	360	[degree]	2-byte integer	2 x nscan1	2	nscan1	1	1
2	SClatitude	-9999.9	-90	90	[degree]	4-byte float	4 x nscan1	4	nscan1	1	1
3	SClongitude	-9999.9	-180	180	[degree]	4-byte float	4 x nscan1	4	nscan1	1	1
4	SCaltitude	-9999.9	0	1000	[km]	4-byte float	4 x nscan1	4	nscan1	1	1
5	FranctionalGranleNumber	-9999.9	0	100000		8-byte float	8 x nscan1	8	nscan1	1	1

(7) Quality (1-byte integer, array size: npixel1 x nscan1)

Quality of Tc in the swath.

GENERAL SPECIFICATIONS

0 = Good data in all channels in the swath

gt 0 = Cautionary warning flags
1-99 = Generic flags (all sensors)
100-127 = Sensor specific flags
lt 0 = Major errors resulting in missing data
-(1-98) = Generic flags (all sensors)
-99 = Missing value (no quality information available)
-(100-127) = Sensor specific flags
DETAILED SPECIFICATIONS
0 = Good data
1 = Possible sun glint
2 = Possible radio frequency interference
3 = Degraded geolocation data
4 = Data corrected for warm load intrusion
102 = Climatology check warning 19V channel
103 = Climatology check warning 19H channel
104 = Climatology check warning 22V channel
105 = Climatology check warning 37V channel
106 = Climatology check warning 37H channel
107 = Climatology check warning 91V channel
108 = Climatology check warning 91H channel
109 = Climatology check warning 150H channel
110 = Climatology check warning 183+/-1 channel
111 = Climatology check warning 183+/-3 channel
112 = Climatology check warning 183+/-7 channel
113 = Climatology check warning Multiple enviro sensor channels
114 = Climatology check warning Multiple imager sensor channels
115 = Climatology check warning One or more LAS sensor channels
116 = Climatology check warning One or more UAS sensor channels
117 = Climatology check warning Correction for lunar intrusion into warm load
118 = Climatology check warning Correction for solar intrusion into warm load
-1 = Data is missing from file or unreadable
-2 = Unphysical brightness temperature (Tb lt 50K or 350K gt Tb)
-3 = Error in geolocation data
-4 = Data missing in one channel
-5 = Data missing in multiple channels
-6 = Lat/lon values are out of range
-7 = Non-normal status modes
-10 = Distance to corresponding LF pixel > 7km
(Used in L1C-R product only)
-99 = Missing value (no quality information available)
-102 = Climatology check flagged in input BASE file
-110 = Climatology check failure 19V channel
-111 = Climatology check failure 19H channel
-112 = Climatology check failure 22V channel
-113 = Climatology check failure 37V channel
-114 = Climatology check failure 37H channel
-115 = Climatology check failure 91V channel
-116 = Climatology check failure 91H channel
-117 = Climatology check failure 150H channel
-118 = Climatology check failure 183+/-1 channel
-119 = Climatology check failure 183+/-3 channel
-120 = Climatology check failure 183+/-7 channel
-121 = Climatology check failure Multiple enviro sensor channels
-122 = Climatology check failure Multiple imager sensor channels
-123 = Climatology check failure One or more LAS sensor channels
-124 = Climatology check failure One or more UAS sensor channels

-125 = Failure of 150H channel on DMSP F18

Table 4.2-12 Quality Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Quality	-99	-	-	-	1-byte integer	1 x 90 x nscan1	1	npixel1	nscan1	1

(8) incidenceAngle (4-byte float, array size: nchUIA1 x npixel1 x nscan1)

Earth incidence angle. Values range from 0 to 90 degrees. Special values are defined as:

-9999.9 Missing value

Table 4.2-13 incidenceAngle Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	incidenceAngle	-9999.9	0	90	[degree]	4-byte float	4 x 1 x 90 x nscan1	4	nchUIA1	npixel1	nscan1

(9) sunGlintAngle (1-byte integer, array size: nchUIA1 x npixel1 x nscan1)

Sun glint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees. Sun below horizon value is -88.

-99 Missing value

Table 4.2-14 sunGlintAngle Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	sunGlintAngle	-99	0	127	[degree]	1-byte integer	1 x 1 x 90 x nscan1	1	nchUIA1	npixel1	nscan1

(10) incidenceAngleIndex (1-byte integer, array size: nchannel1 x nscan1)

Values range from 0 to 100. Special values are defined as:

-99 Missing value

Table 4.2-15 incidenceAngleIndex Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	incidenceAngleIndex	-99	0	100	-	1-byte integer	1 x 3 x nscan1	1	nchannel1	nscan1	1

(11) Tc (4-byte float, array size: nchannel1 x npixel1 x nscan1)

GPM Common Calibrated Brightness Temperature. The channels are:

19.35 GHz vertically-polarized TBs
19.35 GHz horizontally-polarized TBs
22.235 GHz vertically-polarized TBs

Table 4.2-16 Tc Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Tc	-9999.9	0	10000	[K]	4-byte float	4 x 3 x 90 x nscan1	4	nchannel1	npixel1	nscan1

4.2.2.2 S2 (Swath)

(1) S2_SwathHeader (Metadata)

S2_SwathHeader contains metadata for swaths.

Table 4.2-17 S2_SwathHeader Group

Metadata Element	Estimated Size (bytes)	Description
NumberScansInSet	50	The scans read by TKreadScan are a ”set”. For single swath data, one scan is read so NumberScansInSet=1. For multiple swath data, one TKreadScan may read more than one scan. For example, for SSM/I data one TKreadScan reads one low frequency scan and two high frequency scans. Therefore NumberScansInSet=1 for the low frequency swath and NumberScansInSet=2 for the high frequency swath.
MaximumNumberScansTotal	50	The maximum allowed number of total scans in this swath. Total scans = overlap scans before granule + scans in granule + overlap scans after granule.
NumberScansBeforeGranule	50	The number of overlap scans before the first scan of the granule in this swath.
NumberScansGranule	50	The number of scans in the granule in this swath.
NumberScansAfterGranule	50	The number of overlap scans after the last scan of the granule in this swath.
NumberPixels	50	The number of IFOV in each scan in this swath.
ScanType	50	The type of scan in this swath. Values are: ”CROSSTRACK” and ”CONICAL”

(2) S2_IncidenceAngleIndex (Metadata)

S2_IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array.

Table 4.2-18 S2_IncidenceAngleIndex Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	S2_IncidenceAngleIndex	-99	0	100	-	1-byte integer	1 x 2 x nscan2	1	nchannel2	nscan2	1

(3) ScanTime (Group in S2)

Year (2-byte integer, array size: nscan2)

4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:

-9999 Missing value

Month (1-byte integer, array size: nscan2)

Month of the year. Values range from 1 to 12 months. Special values are defined as:

-99 Missing value

DayOfMonth (1-byte integer, array size: nscan2)

Day of the month. Values range from 1 to 31 days. Special values are defined as:

-99 Missing value

Hour (1-byte integer, array size: nscan2)

UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:

-99 Missing value

Minute (1-byte integer, array size: nscan2)

Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:

-99 Missing value

Second (1-byte integer, array size: nscan2)

Second of the minute. Values range from 0 to 60 s. Special values are defined as:

-99 Missing value

MilliSecond (2-byte integer, array size: nscan2)

Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:

-9999 Missing value

DayOfYear (2-byte integer, array size: nscan2)

Day of the year. Values range from 1 to 366 days. Special values are defined as:

-9999 Missing value

SecondOfDay (8-byte float, array size: nscan2)

A time associated with the scan. scanTime sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:

-9999.9 Missing value

Table 4.2-19 ScanTime Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Year	-9999	1950	2100	[year]	2-byte integer	2 x nscan2	2	nscan2	1	1
2	Month	-99	1	12	[month]	1-byte integer	1 x nscan2	1	nscan2	1	1
3	DayOFMonth	-99	1	31	[day]	1-byte integer	1 x nscan2	1	nscan2	1	1
4	Hour	-99	0	23	[hour]	1-byte integer	1 x nscan2	1	nscan2	1	1
5	Minute	-99	0	59	[minute]	1-byte integer	1 x nscan2	1	nscan2	1	1
6	Second	-99	0	60	[s]	1-byte integer	1 x nscan2	1	nscan2	1	1
7	MilliSecond	-9999	0	999	[ms]	2-byte integer	2 x nscan2	2	nscan2	1	1
8	DayOfYear	-9999	1	366	[day]	2-byte integer	2 x nscan2	2	nscan2	1	1
9	SecoundOfDay	-9999.9	0	86400	[s]	8-byte float	8 x nscan2	8	nscan2	1	1

(4) Latitude (4-byte float, array size: npixel2 x nscan2)

The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:

-9999.9 Missing value

Table 4.2-20 Latitude Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Latitude	-9999.9	-90	90	[degree]	4-byte float	4 x 90 x nscan2	4	npixel2	nscan2	1

(5) Longitude (4-byte float, array size: npixel2 x nscan2)

The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:

-9999.9 Missing value

Table 4.2-21 Longitude Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Longitude	-9999.9	-180	180	[degree]	4-byte float	4 x 90 x nscan2	4	npixel2	nscan2	1

(6) SCstatus (Group in S2)

SCorientation (2-byte integer, array size: nscan2)

The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:

-9999 Missing value

SClatitude (4-byte float, array size: nscan2)

Values range from -90 to 90 degrees. Special values are defined as:

-9999.9 Missing value

SClongitude (4-byte float, array size: nscan2)

Values range from -180 to 180 degrees. Special values are defined as:

-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan2)

Values range from 0 to 1000 km. Special values are defined as:

-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan2)

The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:

-9999.9 Missing value

Table 4.2-22 SCStatus Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	SCorientation	-9999	0	360	[degree]	2-byte integer	2 x nscan2	2	nscan2	1	1
2	SClatitude	-9999.9	-90	90	[degree]	4-byte float	4 x nscan2	4	nscan2	1	1
3	SClongitude	-9999.9	-180	180	[degree]	4-byte float	4 x nscan2	4	nscan2	1	1
4	SCaltitude	-9999.9	0	1000	[km]	4-byte float	4 x nscan2	4	nscan2	1	1
5	FranctionalGranleNumber	-9999.9	0	100000		8-byte float	8 x nscan2	8	nscan2	1	1

(7) Quality (1-byte integer, array size: npixel2 x nscan2)

Quality of Tc in the swath.

GENERAL SPECIFICATIONS

0 = Good data in all channels in the swath

gt 0 = Cautionary warning flags

1-99 = Generic flags (all sensors)

100-127 = Sensor specific flags

lt 0 = Major errors resulting in missing data

-(1-98) = Generic flags (all sensors)

-99 = Missing value (no quality information available)

-(100-127) = Sensor specific flags

DETAILED SPECIFICATIONS

0 = Good data
1 = Possible sun glint
2 = Possible radio frequency interference
3 = Degraded geolocation data
4 = Data corrected for warm load intrusion
102 = Climatology check warning 19V channel
103 = Climatology check warning 19H channel
104 = Climatology check warning 22V channel
105 = Climatology check warning 37V channel
106 = Climatology check warning 37H channel
107 = Climatology check warning 91V channel
108 = Climatology check warning 91H channel
109 = Climatology check warning 150H channel
110 = Climatology check warning 183+/-1 channel
111 = Climatology check warning 183+/-3 channel
112 = Climatology check warning 183+/-7 channel
113 = Climatology check warning Multiple enviro sensor channels
114 = Climatology check warning Multiple imager sensor channels
115 = Climatology check warning One or more LAS sensor channels
116 = Climatology check warning One or more UAS sensor channels
117 = Climatology check warning Correction for lunar intrusion into warm load
118 = Climatology check warning Correction for solar intrusion into warm load
-1 = Data is missing from file or unreadable
-2 = Unphysical brightness temperature (Tb lt 50K or 350K gt Tb)
-3 = Error in geolocation data
-4 = Data missing in one channel
-5 = Data missing in multiple channels
-6 = Lat/lon values are out of range
-7 = Non-normal status modes
-10 = Distance to corresponding LF pixel > 7km
(Used in L1C-R product only)
-99 = Missing value (no quality information available)
-102 = Climatology check flagged in input BASE file
-110 = Climatology check failure 19V channel
-111 = Climatology check failure 19H channel
-112 = Climatology check failure 22V channel
-113 = Climatology check failure 37V channel
-114 = Climatology check failure 37H channel
-115 = Climatology check failure 91V channel
-116 = Climatology check failure 91H channel
-117 = Climatology check failure 150H channel
-118 = Climatology check failure 183+/-1 channel
-119 = Climatology check failure 183+/-3 channel
-120 = Climatology check failure 183+/-7 channel
-121 = Climatology check failure Multiple enviro sensor channels
-122 = Climatology check failure Multiple imager sensor channels
-123 = Climatology check failure One or more LAS sensor channels
-124 = Climatology check failure One or more UAS sensor channels
-125 = Failure of 150H channel on DMSP F18

Table 4.2-23 Quality Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Quality	-99	-	-	-	1-byte integer	1 x 90 x nscan2	1	npixel2	nscan2	1

(8) incidenceAngle (4-byte float, array size: nchUIA2 x npixel2 x nscan2)

Earth incidence angle. Values range from 0 to 90 degrees. Special values are defined as:

-9999.9 Missing value

Table 4.2-24 incidenceAngle Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	incidenceAngle	-9999.9	0	90	[degree]	4-byte float	4 x 1 x 90 x nscan2	4	nchUIA2	npixel2	nscan2

(9) sunGlintAngle (1-byte integer, array size: nchUIA2 x npixel2 x nscan2)

Sun glint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees. Sun below horizon value is -88.

-99 Missing value

Table 4.2-25 sunGlintAngle Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	sunGlintAngle	-99	0	127	[degree]	1-byte integer	1 x 1 x 90 x nscan2	1	nchUIA2	npixel2	nscan2

(10) incidenceAngleIndex (1-byte integer, array size: nchannel2 x nscan2)

Values range from 0 to 100. Special values are defined as:

-99 Missing value

Table 4.2-26 incidenceAngleIndex Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	incidenceAngleIndex	-99	0	100	-	1-byte integer	1 x 90 x nscan2	1	nchannel2	nscan2	1

(11) Tc (4-byte float, array size: nchannel2 x npixel2 x nscan2)

GPM Common Calibrated Brightness Temperature. The channels are:

37.0 GHz vertically-polarized TBs

37.0 GHz horizontally-polarized TBs

Table 4.2-27 Tc Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Tc	-9999.9	0	10000	[K]	4-byte float	4 x 2 x 90 x nscan2	4	nchannel2	npixel2	nscan2

4.2.2.3 S3 (Swath)

(1) S3_SwathHeader (Metadata)

S3_SwathHeader contains metadata for swaths.

Table 4.2-28 S3_SwathHeader Group

Metadata Element	Estimated Size (bytes)	Description
NumberScansInSet	50	The scans read by TKreadScan are a ”set”. For single swath data, one scan is read so NumberScansInSet=1. For multiple swath data, one TKreadScan may read more than one scan. For example, for SSM/I data one TKreadScan reads one low frequency scan and two high frequency scans. Therefore NumberScansInSet=1 for the low frequency swath and NumberScansInSet=2 for the high frequency swath.
MaximumNumberScansTotal	50	The maximum allowed number of total scans in this swath. Total scans = overlap scans before granule + scans in granule + overlap scans after granule.
NumberScansBeforeGranule	50	The number of overlap scans before the first scan of the granule in this swath.
NumberScansGranule	50	The number of scans in the granule in this swath.
NumberScansAfterGranule	50	The number of overlap scans after the last scan of the granule in this swath.
NumberPixels	50	The number of IFOV in each scan in this swath.
ScanType	50	The type of scan in this swath. Values are: ”CROSSTRACK” and ”CONICAL”

(2) S3_IncidenceAngleIndex (Metadata)

S3_IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array.

Table 4.2-29 S3_IncidenceAngleIndex Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	S3_IncidenceAngleIndex	-99	0	100	-	1-byte integer	1 x 4 x nscan3	1	nchannel3	nscan3	1

(3) ScanTime (Group in S3)

Year (2-byte integer, array size: nscan3)

4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:

-9999 Missing value

Month (1-byte integer, array size: nscan3)

Month of the year. Values range from 1 to 12 months. Special values are defined as:

-99 Missing value

DayOfMonth (1-byte integer, array size: nscan3)

Day of the month. Values range from 1 to 31 days. Special values are defined as:

-99 Missing value

Hour (1-byte integer, array size: nscan3)

UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:

-99 Missing value

Minute (1-byte integer, array size: nscan3)

Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:

-99 Missing value

Second (1-byte integer, array size: nscan3)

Second of the minute. Values range from 0 to 60 s. Special values are defined as:

-99 Missing value

MilliSecond (2-byte integer, array size: nscan3)

Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:

-9999 Missing value

DayOfYear (2-byte integer, array size: nscan3)

Day of the year. Values range from 1 to 366 days. Special values are defined as:

-9999 Missing value

SecondOfDay (8-byte float, array size: nscan3)

A time associated with the scan. scanTime sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:

-9999.9 Missing value

Table 4.2-30 ScanTime Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Year	-9999	1950	2100	[year]	2-byte integer	2 x nscan3	2	nscan3	1	1
2	Month	-99	1	12	[month]	1-byte integer	1 x nscan3	1	nscan3	1	1
3	DayOFMonth	-99	1	31	[day]	1-byte integer	1 x nscan3	1	nscan3	1	1
4	Hour	-99	0	23	[hour]	1-byte integer	1 x nscan3	1	nscan3	1	1
5	Minute	-99	0	59	[minute]	1-byte integer	1 x nscan3	1	nscan3	1	1
6	Second	-99	0	60	[s]	1-byte integer	1 x nscan3	1	nscan3	1	1
7	MilliSecond	-9999	0	999	[ms]	2-byte integer	2 x nscan3	2	nscan3	1	1
8	DayOfYear	-9999	1	366	[day]	2-byte integer	2 x nscan3	2	nscan3	1	1
9	SecoundOfDay	-9999.9	0	86400	[s]	8-byte float	8 x nscan3	8	nscan3	1	1

(4) Latitude (4-byte float, array size: npixel3 x nscan3)

The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:

-9999.9 Missing value

Table 4.2-31 Latitude Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Latitude	-9999.9	-90	90	[degree]	4-byte float	4 x 180 x nscan3	4	npixel3	nscan3	1

(5) Longitude (4-byte float, array size: npixel3 x nscan3)

The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:

-9999.9 Missing value

Table 4.2-32 Longitude Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Longitude	-9999.9	-180	180	[degree]	4-byte float	4 x 180 x nscan3	4	npixel3	nscan3	1

(6) SCstatus (Group in S3)

SCorientation (2-byte integer, array size: nscan3)

The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:

-9999 Missing value

SClatitude (4-byte float, array size: nscan3)

Values range from -90 to 90 degrees. Special values are defined as:

-9999.9 Missing value

SClongitude (4-byte float, array size: nscan3)

Values range from -180 to 180 degrees. Special values are defined as:

-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan3)

Values range from 0 to 1000 km. Special values are defined as:

-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan3)

The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:

-9999.9 Missing value

Table 4.2-33 SCStatus Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	SCorientation	-9999	0	360	[degree]	2-byte integer	2 x nscan3	2	nscan3	1	1
2	SClatitude	-9999.9	-90	90	[degree]	4-byte float	4 x nscan3	4	nscan3	1	1
3	SClongitude	-9999.9	-180	180	[degree]	4-byte float	4 x nscan3	4	nscan3	1	1
4	SCaltitude	-9999.9	0	1000	[km]	4-byte float	4 x nscan3	4	nscan3	1	1
5	FranctionalGranleNumber	-9999.9	0	100000		8-byte float	8 x nscan3	8	nscan3	1	1

(7) Quality (1-byte integer, array size: npixel3 x nscan3)

Quality of Tc in the swath.

GENERAL SPECIFICATIONS

0 = Good data in all channels in the swath

gt 0 = Cautionary warning flags

1-99 = Generic flags (all sensors)

100-127 = Sensor specific flags

lt 0 = Major errors resulting in missing data

-(1-98) = Generic flags (all sensors)

-99 = Missing value (no quality information available)

-(100-127) = Sensor specific flags

DETAILED SPECIFICATIONS

0 = Good data
1 = Possible sun glint
2 = Possible radio frequency interference
3 = Degraded geolocation data
4 = Data corrected for warm load intrusion
102 = Climatology check warning 19V channel
103 = Climatology check warning 19H channel
104 = Climatology check warning 22V channel
105 = Climatology check warning 37V channel
106 = Climatology check warning 37H channel
107 = Climatology check warning 91V channel
108 = Climatology check warning 91H channel
109 = Climatology check warning 150H channel
110 = Climatology check warning 183+/-1 channel
111 = Climatology check warning 183+/-3 channel
112 = Climatology check warning 183+/-7 channel
113 = Climatology check warning Multiple enviro sensor channels
114 = Climatology check warning Multiple imager sensor channels
115 = Climatology check warning One or more LAS sensor channels
116 = Climatology check warning One or more UAS sensor channels
117 = Climatology check warning Correction for lunar intrusion into warm load
118 = Climatology check warning Correction for solar intrusion into warm load
-1 = Data is missing from file or unreadable
-2 = Unphysical brightness temperature (Tb lt 50K or 350K gt Tb)
-3 = Error in geolocation data
-4 = Data missing in one channel
-5 = Data missing in multiple channels
-6 = Lat/lon values are out of range
-7 = Non-normal status modes
-10 = Distance to corresponding LF pixel > 7km
(Used in L1C-R product only)
-99 = Missing value (no quality information available)
-102 = Climatology check flagged in input BASE file
-110 = Climatology check failure 19V channel
-111 = Climatology check failure 19H channel
-112 = Climatology check failure 22V channel
-113 = Climatology check failure 37V channel
-114 = Climatology check failure 37H channel
-115 = Climatology check failure 91V channel
-116 = Climatology check failure 91H channel
-117 = Climatology check failure 150H channel
-118 = Climatology check failure 183+/-1 channel
-119 = Climatology check failure 183+/-3 channel
-120 = Climatology check failure 183+/-7 channel
-121 = Climatology check failure Multiple enviro sensor channels
-122 = Climatology check failure Multiple imager sensor channels
-123 = Climatology check failure One or more LAS sensor channels
-124 = Climatology check failure One or more UAS sensor channels
-125 = Failure of 150H channel on DMSP F18

Table 4.2-34 Quality Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Quality	-99	-	-	-	1-byte integer	1 x 180 x nscan3	1	npixel3	nscan3	1

(8) incidenceAngle (4-byte float, array size: nchUIA3 x npixel3 x nscan3)

Earth incidence angle. Values range from 0 to 90 degrees. Special values are defined as:

-9999.9 Missing value

Table 4.2-35 incidenceAngle Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	incidenceAngle	-9999.9	0	90	[degree]	4-byte float	4 x 1 x 180 x nscan3	4	nchUIA3	npixel3	nscan3

(9) sunGlintAngle (1-byte integer, array size: nchUIA3 x npixel3 x nscan3)

Sun glint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees. Sun below horizon value is -88. Missing value is -99.

Table 4.2-36 sunGlintAngle Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	sunGlintAngle	-99	0	127	[degree]	1-byte integer	1 x 1 x 180 x nscan3	1	nchUIA3	npixel3	nscan3

(10) incidenceAngleIndex (1-byte integer, array size: nchannel3 x nscan3)

Values range from 0 to 100. Special values are defined as:

-99 Missing value

Table 4.2-37 incidenceAngleIndex Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	incidenceAngleIndex	-99	0	100	-	1-byte integer	1 x 180 x nscan3	1	nchannel3	nscan3	1

(11) Tc (4-byte float, array size: nchannel3 x npixel3 x nscan3)

GPM Common Calibrated Brightness Temperature. The channels are:

150 GHz horizontally-polarized TBs
183.31 +/- 1 GHz horizontally-polarized TBs
183.31 +/- 3 GHz horizontally-polarized TBs
183.31 +/- 7 GHz horizontally-polarized TBs

Table 4.2-38 Tc Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Tc	-9999.9	0	10000	[K]	4-byte float	4 x 4 x 180 x nscan3	4	nchannel3	npixel3	nscan3

4.2.2.4 S4 (Swath)

(1) S4_SwathHeader (Metadata)

S4_SwathHeader contains metadata for swaths.

Table 4.2-39 S4_SwathHeader Group

Metadata Element	Estimated Size (bytes)	Description
NumberScansInSet	50	The scans read by TKreadScan are a ”set”. For single swath data, one scan is read so NumberScansInSet=1. For multiple swath data, one TKreadScan may read more than one scan. For example, for SSM/I data one TKreadScan reads one low frequency scan and two high frequency scans. Therefore NumberScansInSet=1 for the low frequency swath and NumberScansInSet=2 for the high frequency swath.
MaximumNumberScansTotal	50	The maximum allowed number of total scans in this swath. Total scans = overlap scans before granule + scans in granule + overlap scans after granule.
NumberScansBeforeGranule	50	The number of overlap scans before the first scan of the granule in this swath.
NumberScansGranule	50	The number of scans in the granule in this swath.
NumberScansAfterGranule	50	The number of overlap scans after the last scan of the granule in this swath.
NumberPixels	50	The number of IFOV in each scan in this swath.
ScanType	50	The type of scan in this swath. Values are: ”CROSSTRACK” and ”CONICAL”

(2) S4_IncidenceAngleIndex (Metadata)

S4_IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array.

Table 4.2-40 S4_IncidenceAngleIndex Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	S4_IncidenceAngleIndex	-99	0	100	-	1-byte integer	1 x 2 x nscan4	1	nchannel4	nscan4	1

(3) ScanTime (Group in S4)

Year (2-byte integer, array size: nscan4)

4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:

-9999 Missing value

Month (1-byte integer, array size: nscan4)

Month of the year. Values range from 1 to 12 months. Special values are defined as:

-99 Missing value

DayOfMonth (1-byte integer, array size: nscan4)

Day of the month. Values range from 1 to 31 days. Special values are defined as:

-99 Missing value

Hour (1-byte integer, array size: nscan4)

UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:

-99 Missing value

Minute (1-byte integer, array size: nscan4)

Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:

-99 Missing value

Second (1-byte integer, array size: nscan4)

Second of the minute. Values range from 0 to 60 s. Special values are defined as:

-99 Missing value

MilliSecond (2-byte integer, array size: nscan4)

Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:

-9999 Missing value

DayOfYear (2-byte integer, array size: nscan4)

Day of the year. Values range from 1 to 366 days. Special values are defined as:

-9999 Missing value

SecondOfDay (8-byte float, array size: nscan4)

A time associated with the scan. scanTime sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:

-9999.9 Missing value

Table 4.2-41 ScanTime Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Year	-9999	1950	2100	[year]	2-byte integer	2 x nscan4	2	nscan4	1	1
2	Month	-99	1	12	[month]	1-byte integer	1 x nscan4	1	nscan4	1	1
3	DayOFMonth	-99	1	31	[day]	1-byte integer	1 x nscan4	1	nscan4	1	1
4	Hour	-99	0	23	[hour]	1-byte integer	1 x nscan4	1	nscan4	1	1
5	Minute	-99	0	59	[minute]	1-byte integer	1 x nscan4	1	nscan4	1	1
6	Second	-99	0	60	[s]	1-byte integer	1 x nscan4	1	nscan4	1	1
7	MilliSecond	-9999	0	999	[ms]	2-byte integer	2 x nscan4	2	nscan4	1	1
8	DayOfYear	-9999	1	366	[day]	2-byte integer	2 x nscan4	2	nscan4	1	1
9	SecoundOfDay	-9999.9	0	86400	[s]	8-byte float	8 x nscan4	8	nscan4	1	1

(4) Latitude (4-byte float, array size: npixel4 x nscan4)

The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:

-9999.9 Missing value

Table 4.2-42 Latitude Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Latitude	-9999.9	-90	90	[degree]	4-byte float	4 x 180 x nscan4	4	npixel4	nscan4	1

(5) Longitude (4-byte float, array size: npixel4 x nscan4)

The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:

-9999.9 Missing value

Table 4.2-43 Longitude Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Longitude	-9999.9	-180	180	[degree]	4-byte float	4 x 180 x nscan4	4	npixel4	nscan4	1

(6) SCstatus (Group in S4)

SCorientation (2-byte integer, array size: nscan4)

The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:

-9999 Missing value

SClatitude (4-byte float, array size: nscan4)

Values range from -90 to 90 degrees. Special values are defined as:

-9999.9 Missing value

SClongitude (4-byte float, array size: nscan4)

Values range from -180 to 180 degrees. Special values are defined as:

-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan4)

Values range from 0 to 1000 km. Special values are defined as:

-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan4)

The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:

-9999.9 Missing value

Table 4.2-44 SCStatus Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	SCorientation	-9999	0	360	[degree]	2-byte integer	2 x nscan4	2	nscan4	1	1
2	SClatitude	-9999.9	-90	90	[degree]	4-byte float	4 x nscan4	4	nscan4	1	1
3	SClongitude	-9999.9	-180	180	[degree]	4-byte float	4 x nscan4	4	nscan4	1	1
4	SCaltitude	-9999.9	0	1000	[km]	4-byte float	4 x nscan4	4	nscan4	1	1
5	FranctionalGranleNumber	-9999.9	0	100000		8-byte float	8 x nscan4	8	nscan4	1	1

(7) Quality (1-byte integer, array size: npixel4 x nscan4)

Quality of Tc in the swath.

GENERAL SPECIFICATIONS

0 = Good data in all channels in the swath

gt 0 = Cautionary warning flags

1-99 = Generic flags (all sensors)

100-127 = Sensor specific flags

lt 0 = Major errors resulting in missing data

-(1-98) = Generic flags (all sensors)

-99 = Missing value (no quality information available)

-(100-127) = Sensor specific flags

DETAILED SPECIFICATIONS

0 = Good data
1 = Possible sun glint
2 = Possible radio frequency interference
3 = Degraded geolocation data
4 = Data corrected for warm load intrusion
102 = Climatology check warning 19V channel
103 = Climatology check warning 19H channel
104 = Climatology check warning 22V channel
105 = Climatology check warning 37V channel
106 = Climatology check warning 37H channel
107 = Climatology check warning 91V channel
108 = Climatology check warning 91H channel
109 = Climatology check warning 150H channel
110 = Climatology check warning 183+/-1 channel
111 = Climatology check warning 183+/-3 channel
112 = Climatology check warning 183+/-7 channel
113 = Climatology check warning Multiple enviro sensor channels
114 = Climatology check warning Multiple imager sensor channels
115 = Climatology check warning One or more LAS sensor channels
116 = Climatology check warning One or more UAS sensor channels
117 = Climatology check warning Correction for lunar intrusion into warm load
118 = Climatology check warning Correction for solar intrusion into warm load
-1 = Data is missing from file or unreadable
-2 = Unphysical brightness temperature (Tb lt 50K or 350K gt Tb)
-3 = Error in geolocation data
-4 = Data missing in one channel
-5 = Data missing in multiple channels
-6 = Lat/lon values are out of range
-7 = Non-normal status modes
-10 = Distance to corresponding LF pixel > 7km
(Used in L1C-R product only)
-99 = Missing value (no quality information available)
-102 = Climatology check flagged in input BASE file
-110 = Climatology check failure 19V channel
-111 = Climatology check failure 19H channel
-112 = Climatology check failure 22V channel
-113 = Climatology check failure 37V channel
-114 = Climatology check failure 37H channel
-115 = Climatology check failure 91V channel
-116 = Climatology check failure 91H channel
-117 = Climatology check failure 150H channel
-118 = Climatology check failure 183+/-1 channel
-119 = Climatology check failure 183+/-3 channel
-120 = Climatology check failure 183+/-7 channel
-121 = Climatology check failure Multiple enviro sensor channels
-122 = Climatology check failure Multiple imager sensor channels
-123 = Climatology check failure One or more LAS sensor channels
-124 = Climatology check failure One or more UAS sensor channels
-125 = Failure of 150H channel on DMSP F18

Table 4.2-45 Quality Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Quality	-99	-	-	-	1-byte integer	1 x 180 x nscan4	4	npixel4	nscan4	1

(8) incidenceAngle (4-byte float, array size: nchUIA4 x npixel4 x nscan4)

Earth incidence angle. Values range from 0 to 90 degrees. Special values are defined as:

-9999.9 Missing value

Table 4.2-46 incidenceAngle Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	incidenceAngle	-9999.9	0	90	[degree]	4-byte float	4 x 1 x 180 x nscan4	4	nchUIA4	npixel4	nscan4

(9) sunGlintAngle (1-byte integer, array size: nchUIA4 x npixel4 x nscan4)

Sun glint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees. Sun below horizon value is -88.

-99 Missing value

Table 4.2-47 sunGlintAngle Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	sunGlintAngle	-99	0	127	[degree]	1-byte integer	1 x 1 x 180 x nscan4	1	nchUIA4	npixel4	nscan4

(10) incidenceAngleIndex (1-byte integer, array size: nchannel4 x nscan4)

Values range from 0 to 100. Special values are defined as:

-99 Missing value

Table 4.2-48 incidenceAngleIndex Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	incidenceAngleIndex	-99	0	100	-	1-byte integer	1 x 2 x nscan4	1	nchannel4	nscan4	1

(11) Tc (4-byte float, array size: nchannel4 x npixel4 x nscan4)

GPM Common Calibrated Brightness Temperature. The channels are:

91.665 GHz vertically-polarized TBs

91.665 GHz horizontally-polarized TBs

Table 4.2-49 Tc Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Tc	-9999.9	0	10000	[K]	4-byte float	4 x 2 x 180 x nscan4	4	nchannel4	npixel4	nscan4

5. 1CATMS - Common Calibrated Brightness Temperature

5.1. Data Format Structure

5.1.1. Dimension definition

Dimension definitions:

- nscan1
  - var Number of Swath 1 scans in the granule.
- nchannel1
  - 1 Number of Swath 1 channels.
- npixel1
  - 96 Number of Swath 1 pixels in one scan.
- nchUIA1
  - 1 Number of Swath S1 unique incidence angles.
- nscan2
  - var Number of Swath 2 scans in the granule.
- nchannel2
  - 1 Number of Swath 2 channels.
- npixel1
  - 96 Number of Swath 2 pixels in one scan.
- nchUIA2
  - 1 Number of Swath S2 unique incidence angles.
- nscan3
  - var Number of Swath 3 scans in the granule.
- nchannel3
  - 1 Number of Swath 3 channels.
- npixel3
  - 96 Number of Swath 3 pixels in one scan.
- nchUIA3
  - 1 Number of Swath S3 unique incidence angles.
- nscan4
  - var Number of Swath 4 scans in the granule.
- nchannel4
  - 6 Number of Swath 4 channels.
- npixel4
  - 96 Number of Swath 4 pixels in one scan.
- nchUIA4
  - 1 Number of Swath S4 unique incidence angles.

5.1.2. Data Format Structure for 1CATMS – Common Calibrated Brightness Temperature

1CATMS contains common calibrated brightness temperature from the ATMS passive microwave instrument flown on the Suomi NPP satellite and JPSS satellites. ATMS is approximatly a combination of the AMSU-A channels and the MHS channels. ATMS rotates 3 scans per 8 seconds. ATMS has the following 22 channels:

Ch	GHz	Pol
1	23.8	QV
2	31.4	QV
3	50.3	QH
4	51.76	QH
5	52.8	QH
6	53.59+-0.115	QH
7	54.4	QH
8	54.94	QH
9	55.5	QH
10	fo=57.29	QH
11	fo+--0.3222+-0.217	QH
12	fo+--0.3222+-0.048	QH
13	fo+--0.3222+-0.022	QH
14	fo+--0.3222+-0.010	QH
15	fo+--0.3222+-0.0045	QH
16	88.2	QV
17	165.5	QH
18	183.31+-7	QH
19	183.31+-4.5	QH
20	183.31+-3	QH
21	183.31+-1.8	QH
22	183.31+-1	QH

QV means quasi-vertical;
The polarization vector is parallel to the scan plane at nadir.
QH meansquasi-horizaontal polarization.
Note on geolocation and 1C swaths;
The BeamLatitude and BeamLongitude in ATMSBASE have a band dimentsion of 5. Lat and lon is for channels 1, 2, 3, 16, 17. Each 1C swath will contain one band:

1C swath	Band	IEEE GHz	Ch geo	Chs in band
1	K	18-26.5	1	1
2	A(Ka)	26.5-40	2	2
3	W	75-110	16	16
4	G	110-300	17	17-22

Note that channels 3-15 are Not Included in the 1C product.

1CATMS contains 4 swaths, one for each band K, A(Ka), W, and G.

RELATION BETWEEN THE SWATHS: All 4 swaths contain observation sampled 96 times along the scan.

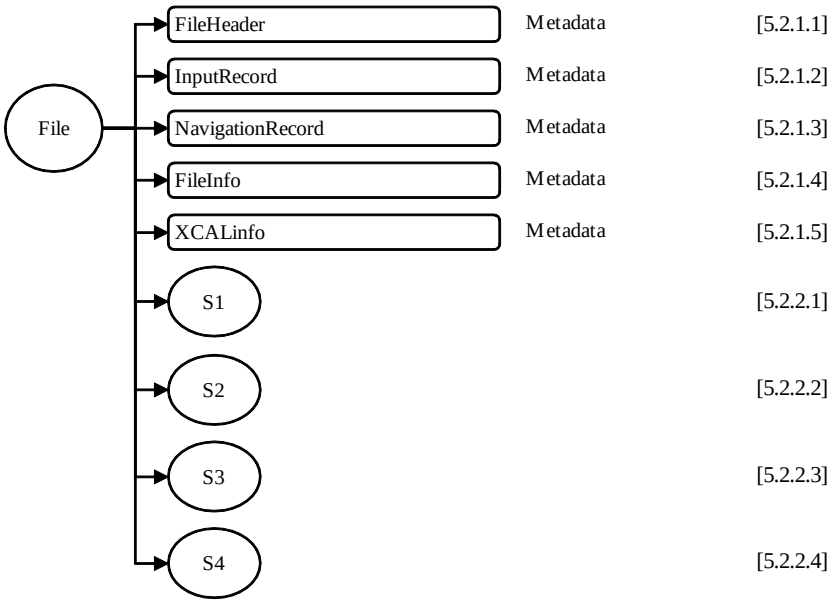

Figure 5.1-1 Data Format Structure for 1CATMS – Common Calibrated Brightness Temperature

5.1.3. Data Format Structure for each Group

5.1.3.1 Data Format Structure for S1 Group

S1 Group's structure is shown in this section.

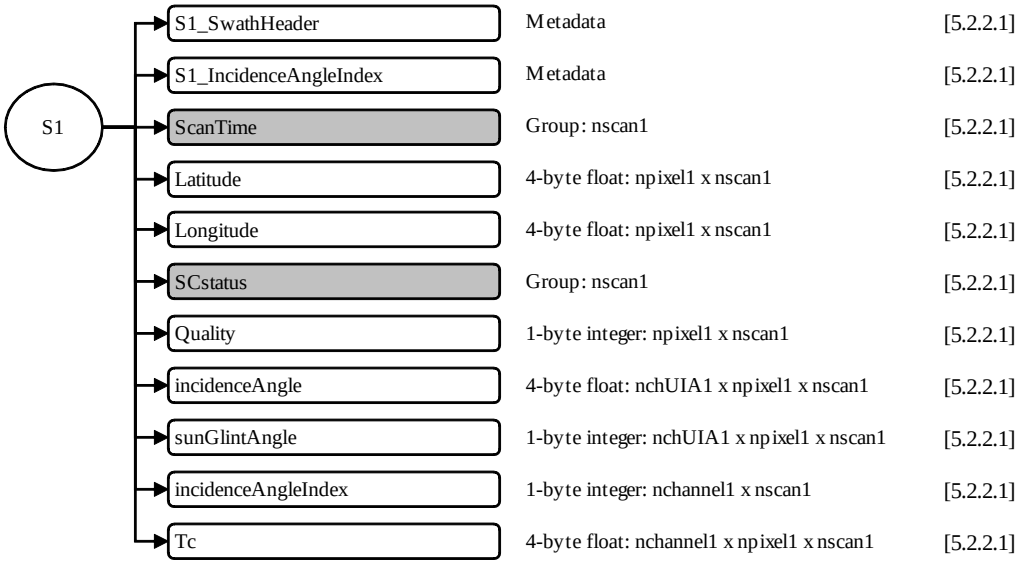

Figure 5.1-2 Data Format Structure for 1CATMS, S1

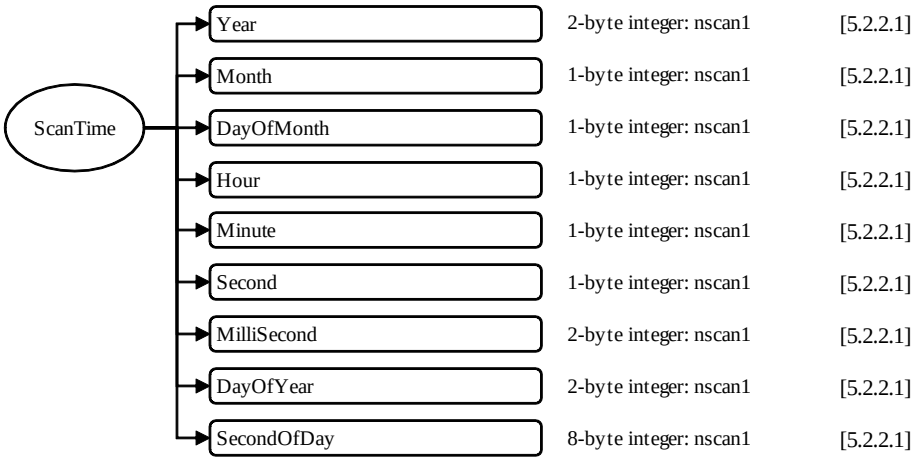

Figure 5.1-3 Data Format Structure for 1CATMS, ScanTime

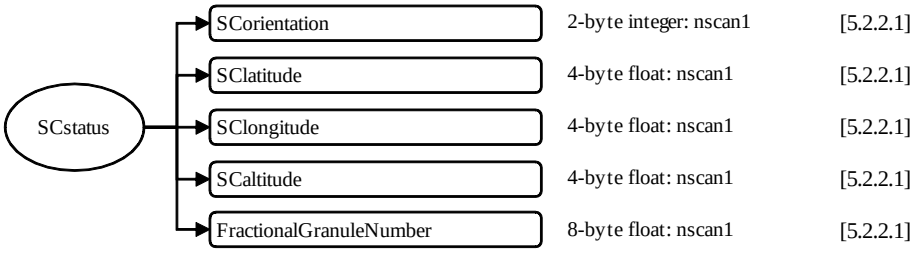

Figure 5.1-4 Data Format Structure for 1CATMS, SCstatus

5.1.3.2 Data Format Structure for S2 Group

S2 Group's structure is shown in this section.

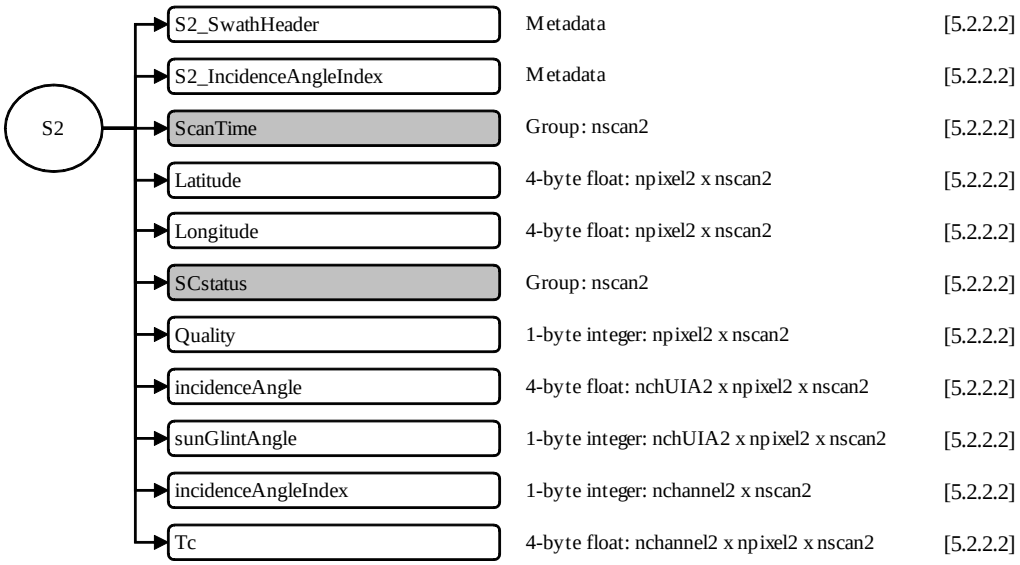

Figure 5.1-5 Data Format Structure for 1CATMS, S2

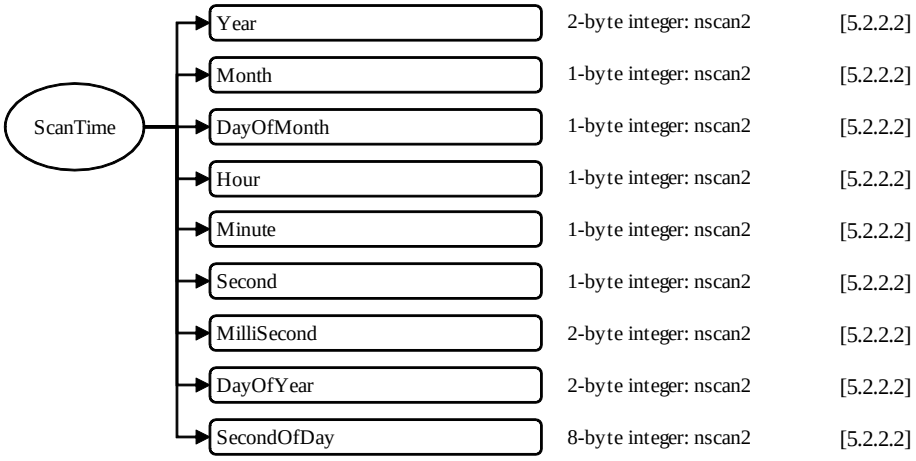

Figure 5.1-6 Data Format Structure for 1CATMS, S2, ScanTime

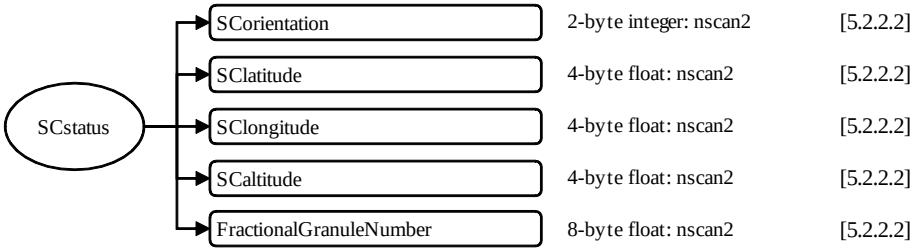

Figure 5.1-7 Data Format Structure for 1CATMS, S2, SCstatus

5.1.3.3 Data Format Structure for S3 Group

S3 Group's structure is shown in this section.

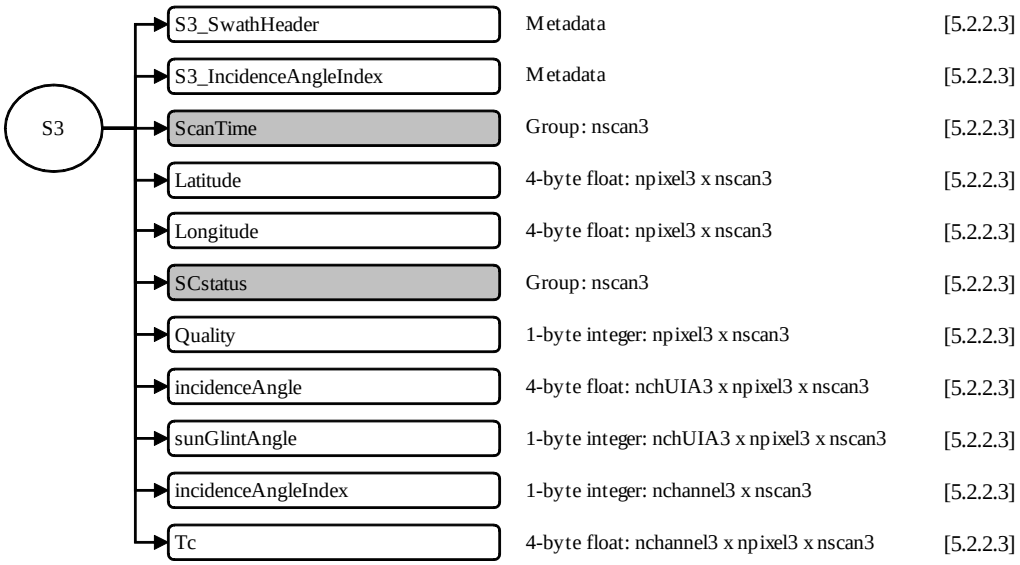

Figure 5.1-8 Data Format Structure for 1CATMS, S3

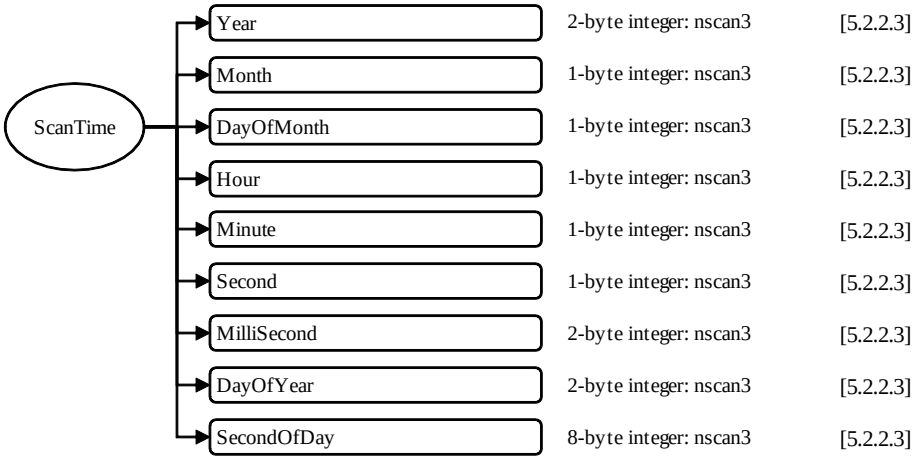

Figure 5.1-9 Data Format Structure for 1CATMS, S3, ScanTime

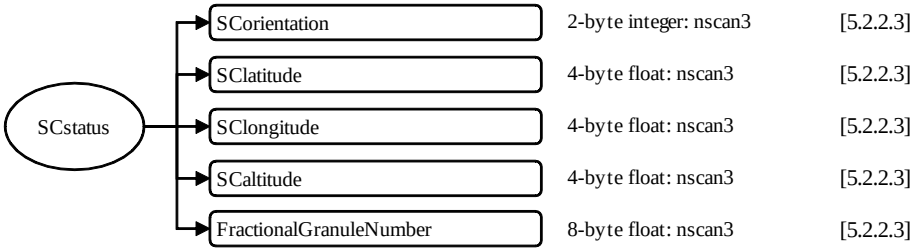

Figure 5.1-10 Data Format Structure for 1CATMS, S3, SCstatus

5.1.3.4 Data Format Structure for S4 Group

S4 Group's structure is shown in this section.

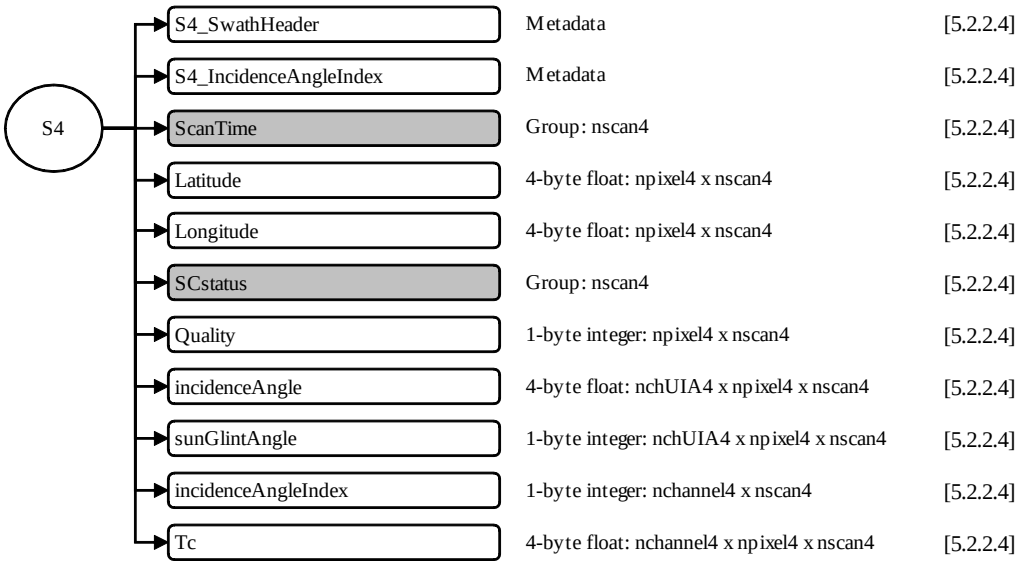

Figure 5.1-11 Data Format Structure for 1CATMS, S4

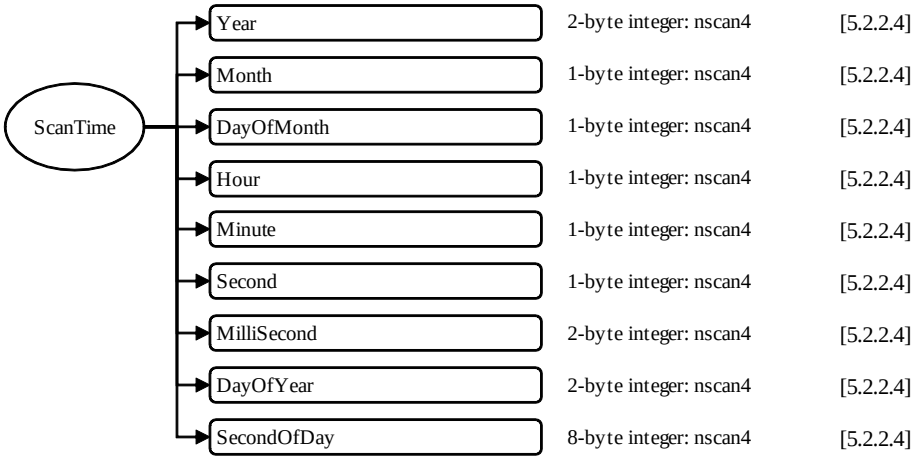

Figure 5.1-12 Data Format Structure for 1CATMS, S4, ScanTime

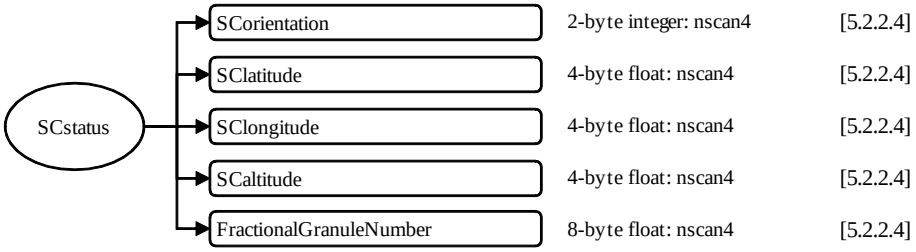

Figure 5.1-13 Data Format Structure for 1CATMS, S4, SCstatus

5.2. Contents of objects in each Group

5.2.1. Metadata

5.2.1.1 FileHeader

FileHeader contains metadata of general interest. Table 5.2-1 shows each metadata elements in FileHeader.

Table 5.2-1 FileHeader Group

Metadata Element	Estimated Size (bytes)	Description
DOI	256	Digital Object Identifier *Value is blank currently
DOIauthority	256	Digital Object Identifier Authority.
DOIshortName	256	Digital Object Identifier Short Name. *Value is blank currently.
AlgorithmID	50	The algorithm that generated this product, e.g., 2A12.
AlgorithmVersion	50	The version of the algorithm that generated this product.
FileName	50	The file name of this granule.
SatelliteName	10	Values are: TRMM GPM MULTI F10 ... F18 AQUA GCOMW1 CORIOLIS MT1 NOAA15 ... NOAA19 METOPANPP. More values will be added as they are known.
InstrumentName	10	Values are: PR TMI VIRS PRTMI KU KA DPR GMI DPRGMI MERGED SSMI SSMIS AMSRE AMSR2 WIND-SAT MADRAS AMSUA AMSUB SAPHIR MHS ATMS. More values will be added as they are known.
GenerationDateTime	50	The date and time this granule was generated. The format is YYYY-MM-DDTHH:MM:SS.sssZ, where YYYY is 4-digit year, MM is month number, DD is day of month, T is ”T”, HH is hour, MM is minute, SS is second, sss is millisecond, and Z is ”Z”. All fields are zero-filled. The missing value is constructed by replacing all digits with 9, i.e., 9999-99-99T99:99:99.999Z
StartGranuleDateTime	50	The start time defining this granule. The format is the same as GenerationDateTime. DETAILS: An orbital granule starts when the satellite is at the position defined by GranuleStart. Thus the start time is not the first scan time. Some algorithms have overlap scans in the file before the start time as defined in SwathHeader. A monthly granule starts on the first ms of the month, for example March 1998 would be 1998-03-01T00:00:00.000Z
StopGranuleDateTime	50	The stop time defining this granule. The format is the same as GenerationDateTime. DETAILS: An orbital granule stops when the satellite is at the position defined by GranuleStart. Thus the stop time is not the last scan time. Some algorithms have overlap scans in the file after the stop time as defined in SwathHeader. A monthly granule stops on the last ms of the month, for example March 1998 would be 1998-03-31T23:59:59.999Z
GranuleNumber	50	The number of this granule, which starts as in GranuleStart. If the GranuleStart is identical to the orbit start, then the GranuleNumber will be the same as the orbit number. The GranuleNumber will have 6 digits, including leading zeroes, for example 001234.
NumberOfSwaths	50	The number of swaths in this granule.
NumberOfGrids	50	The number of grid structures in this granule.
GranuleStart	50	The starting place in the orbit of this granule. Currently defined values are ”SOUTHERNMOST LATITUDE” and ”NORTHBOUND EQUATOR CROSSING”.
TimeInterval	50	The time interval covered by this granule. Values are ”ORBIT”, ”HALF ORBIT”, ”HALF HOUR”, ”HOUR”, ”3 HOUR”, ”DAY”, ”MONTH”, ”CONTACT”.

Metadata Element	Estimated Size (bytes)	Description
ProcessingSystem	50	The name of the processing system, e.g., ”PPS”, ”JAXA”.
ProductVersion	50	The data version assigned by the processing system.
EmptyGranule	50	Whether a granule is empty. Values are ”EMPTY” or ”NOT EMPTY”.
MissingData	50	The number of missing scans.

5.2.1.2 InputRecord

InputRecord contains a record of input files for this granule. Table 5.2-2 shows each metadata elements in InputRecord.

Table 5.2-2 InputRecord Group

Metadata Element	Estimated Size (bytes)	Description
InputFileName	1000	A list of input file names for this granule.
InputAlgorithmVersions	1000	A list of algorithm versions of the input files for this granule.
InputGenerationDatteTimes	1000	A list of generation date times of the input files for this granule. The format is the same as GenerationDateTime.

5.2.1.3 NavigationRecord

NavigationRecord contains navigation metadata for this granule. Table 5.2-3 shows each metadata elements in NavigationRecord.

Table 5.2-3 NavigationRecord Group

Metadata Element	Estimated Size (bytes)	Description
LongitudeOnEquator	50	The longitude where the satellite crosses the equator going from south to north.
UTCDateTimeOnEquator	50	The UTC time when the satellite crosses the equator going from south to north. The format is the same as GenerationDate Time.
MeanSolarBetaAngle	50	The average solar beta angle in this granule.
EphemerisFileName	50	Name of the ephemeris file input for processing.
AttitudeFileName	50	Name of the attitude file input for processing.
GeoControlFileName	50	Name of the GeoTK Control Parameters File input for processing.
EphemerisSource	50	Values are ”0 CONSTANT INPUT TEST VALUE”, ”1 GROUND ESTIMATED STATE (GES)”, ”2 GPS FILTERED SOLUTION (GEONS)”, ”3 GPS POINT SOLUTION (PVT)”, ”4 ON BOARD PROPAGATED (OBP)”, ”5 OEM GROUND EPHEMERIS FILE”, ”6 GEONS WITH FALLBACK AS FLAGGED”, ”7 PVT WITH FALLBACK AS FLAGGED”, ”8 OBP WITH FALLBACK AS FLAGGED”, ”9 GES WITH FALLBACK AS FLAGGED”
AttitudeSource	50	Values are ”0 CONSTANT INPUTS FOR TESTING”, ”1 ON BOARD CALCULATED PITCH ROLL YAW”
GeoToolkitVersion	50	Version of the GeoToolkit
SensorAlignmentFirstRotationAngle	50	Alignment angle, first rotation, in degrees. Rotation adjustment from sensor coordinates to the Attitude Control System Flight Coordinates.
SensorAlignmentSecondRotationAngle	50	Alignment angle, second rotation, in degrees.
SensorAlignmentThirdRotationAngle	50	Alignment angle, third rotation, in degrees.

Metadata Element	Estimated Size (bytes)	Description
SensorAlignmentFirstRotationAxis	50	Euler rotation sequence, first rotation axis. Values are ”1”, ”2”, ”3” (representing X, Y, Z).
SensorAlignmentSecondRotationAxis	50	Euler rotation sequence, second rotation axis. Values are ”1”, ”2”, ”3” (representing X, Y, Z).
SensorAlignmentThirdRotationAxis	50	Euler rotation sequence, third rotation axis. Values are ”1”, ”2”, ”3” (representing X, Y, Z).

5.2.1.4 FileInfo

FileInfo contains metadata used by the PPS I/O Toolkit. Table 5.2-4 shows each metadata elements in FileInfo.

Table 5.2-4 FileInfo Group

Metadata Element	Estimated Size (bytes)	Description
DataFormatVersion	50	The version of the data format used to write this file. This version is separate for each AlgorithmID. The order is: ”a” ”b” ... ”z” ”aa” ”ab” ... ”az” ”ba” ”bb” ...
TKCodeBuildVersion	50	Usually TK CodeBuildVersion is ”1”. If the I/O routines built by TKIO change even though the DataFormatVersion is unchanged, then TK CodeBuildVersion increments to ”2”, ”3”, ... If subsequently DataFormatVersion changes, TKCodeBuildVersion becomes ”1” again.
MetadataVersion	50	The version of metadata used to write this file. This version is separate for each AlgorithmID. The order is: ”a” ”b” ... ”z” ”aa” ”ab” ... ”az” ”ba” ”bb” ...
FormatPackage	50	The underlying format of this granule. Values are ”HDF4”, ”HDF5”, ”NETCDF”, ”TKBINARY”
BlueprintFilename	50	The filename of the primary blueprint file that defined the format used to write this file.
BlueprintVersion	10	The BlueprintVersion of the format definition
TKIOVersion	50	The version of TKIO used to create I/O routines to write this file. TKIOVersion does not define the format used to write this file.
MetadataStyle	50	The style in which the metadata was written, e.g., ”PVL”. ”PVL” means < parameter >=< value >;
EndianType	50	The endian type of the system that wrote this file. Values are ”BIG ENDIAN” and ”LITTLE ENDIAN”.

5.2.1.5 XCALinfo

XCALinfo contains metadata required by 1C intercalibrated files.

Table 5.2-5 XCALinfo Group

Metadata Element	Estimated Size (bytes)	Description
CalibrationStandard	50	The brightness temperature reference standard, e.g., ”cc 1.1”.
CalibrationTable	50	The name of a file containing the calibration table used to make this product, e.g., ”1C.AQUA.ASMRE.XCAL2013-P.tbl”.
CalibrationLevel	50	The level development of the intercalibration for a given sensor. When this level increases for a given sensor the Level 1C files are reprocessed and the version number will also increment. The intercalibration level is defined as follows: N (None): No intercalibration has been applied. Tbs are unchanged from Level 1B source files.

Metadata Element	Estimated Size (bytes)	Description
		P (Preliminary): A preliminary or beta intercalibration has been applied to match the Tb to the reference. V (Verified): The intercalibration has been verified by at least one independent effort. C (Consensus): The XCAL intercalibration has been finalized and accepted by the Science Team.

5.2.2. Data Group

Elements of data group are explained in detail in this section.

5.2.2.1 S1 (Swath)

(1) S1_SwathHeader (Metadata)

S1_SwathHeader contains metadata for swaths.

Table 5.2-6 S1_SwathHeader Group

Metadata Element	Estimated Size (bytes)	Description
NumberScansInSet	50	The scans read by TKreadScan are a ”set”. For single swath data, one scan is read so NumberScansInSet=1. For multiple swath data, one TKreadScan may read more than one scan. For example, for SSM/I data one TKreadScan reads one low frequency scan and two high frequency scans. Therefore NumberScansInSet=1 for the low frequency swath and NumberScansInSet=2 for the high frequency swath.
MaximumNumberScansTotal	50	The maximum allowed number of total scans in this swath. Total scans = overlap scans before granule + scans in granule + overlap scans after granule.
NumberScansBeforeGranule	50	The number of overlap scans before the first scan of the granule in this swath.
NumberScansGranule	50	The number of scans in the granule in this swath.
NumberScansAfterGranule	50	The number of overlap scans after the last scan of the granule in this swath.
NumberPixels	50	The number of IFOV in each scan in this swath.
ScanType	50	The type of scan in this swath. Values are: ”CROSSTRACK” and ”CONICAL”

(2) S1_IncidenceAngleIndex (Metadata)

S1_IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array.

Table 5.2-7 S1_IncidenceAngleIndex Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	S1_IncidenceAngleIndex	-99	0	100	-	1-byte integer	1 x 1 x nscan1	1	nchannel1	nscan1	1

(3) ScanTime (Group in S1)

Year (2-byte integer, array size: nscan1)

4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:

-9999 Missing value

Month (1-byte integer, array size: nscan1)

Month of the year. Values range from 1 to 12 months. Special values are defined as:

-99 Missing value

DayOfMonth (1-byte integer, array size: nscan1)

Day of the month. Values range from 1 to 31 days. Special values are defined as:

-99 Missing value

Hour (1-byte integer, array size: nscan1)

UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:

-99 Missing value

Minute (1-byte integer, array size: nscan1)

Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:

-99 Missing value

Second (1-byte integer, array size: nscan1)

Second of the minute. Values range from 0 to 60 s. Special values are defined as:

-99 Missing value

MilliSecond (2-byte integer, array size: nscan1)

Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:

-9999 Missing value

DayOfYear (2-byte integer, array size: nscan1)

Day of the year. Values range from 1 to 366 days. Special values are defined as:

-9999 Missing value

SecondOfDay (8-byte float, array size: nscan1)

A time associated with the scan. scanTime sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:

-9999.9 Missing value

Table 5.2-8 ScanTime Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Year	-9999	1950	2100	[year]	2-byte integer	2 x nscan1	2	nscan1	1	1
2	Month	-99	1	12	[month]	1-byte integer	1 x nscan1	1	nscan1	1	1
3	DayOFMonth	-99	1	31	[day]	1-byte integer	1 x nscan1	1	nscan1	1	1
4	Hour	-99	0	23	[hour]	1-byte integer	1 x nscan1	1	nscan1	1	1
5	Minute	-99	0	59	[minute]	1-byte integer	1 x nscan1	1	nscan1	1	1
6	Second	-99	0	60	[s]	1-byte integer	1 x nscan1	1	nscan1	1	1
7	MilliSecond	-9999	0	999	[ms]	2-byte integer	2 x nscan1	2	nscan1	1	1
8	DayOfYear	-9999	1	366	[day]	2-byte integer	2 x nscan1	2	nscan1	1	1
9	SecoundOfDay	-9999.9	0	86400	[s]	8-byte float	8 x nscan1	8	nscan1	1	1

(4) Latitude (4-byte float, array size: npixel1 x nscan1)

The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:

-9999.9 Missing value

Table 5.2-9 Latitude Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Latitude	-9999.9	-90	90	[degree]	4-byte float	4 x 96 x nscan1	4	npixel1	nscan1	1

(5) Longitude (4-byte float, array size: npixel1 x nscan1)

The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:

-9999.9 Missing value

Table 5.2-10 Longitude Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Longitude	-9999.9	-180	180	[degree]	4-byte float	4 x 96 x nscan1	4	npixel1	nscan1	1

(6) SCstatus (Group in S1)

SCorientation (2-byte integer, array size: nscan1)

The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:

-9999 Missing value

SClatitude (4-byte float, array size: nscan1)

Values range from -90 to 90 degrees. Special values are defined as:

-9999.9 Missing value

SClongitude (4-byte float, array size: nscan1)

Values range from -180 to 180 degrees. Special values are defined as:

-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan1)

Values range from 0 to 1000 km. Special values are defined as:

-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan1)

The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:

-9999.9 Missing value

Table 5.2-11 SCStatus Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	SCorientation	-9999	0	360	[degree]	2-byte integer	2 x nscan1	2	nscan1	1	1
2	SClatitude	-9999.9	-90	90	[degree]	4-byte float	4 x nscan1	4	nscan1	1	1
3	SClongitude	-9999.9	-180	180	[degree]	4-byte float	4 x nscan1	4	nscan1	1	1
4	SCaltitude	-9999.9	0	1000	[km]	4-byte float	4 x nscan1	4	nscan1	1	1
5	FranctionalGranleNumber	-9999.9	0	100000		8-byte float	8 x nscan1	8	nscan1	1	1

(7) Quality (1-byte integer, array size: npixel1 x nscan1)

Quality of Tc in the swath.

GENERAL SPECIFICATIONS

0 = Good data in all channels in the swath

gt 0 = Cautionary warning flags

1-99 = Generic flags (all sensors)

100-127 = Sensor specific flags

lt 0 = Major errors resulting in missing data

-(1-98) = Generic flags (all sensors)

-99 = Missing value (no quality information available)

-(100-127) = Sensor specific flags

DETAILED SPECIFICATIONS

0 = Good data

1 = Possible sun glint

2 = Possible radio frequency interference

3 = Degraded geolocation data

4 = Data corrected for warm load intrusion

-1 = Data is missing from file or unreadable

-2 = Unphysical brightness temperature (Tb lt 50K or 350K gt Tb)

-3 = Error in geolocation data

-4 = Data missing in one channel

-5 = Data missing in multiple channels

-6 = Lat/lon values are out of range

-7 = Non-normal status modes

-10 = Distance to corresponding LF pixel > 7 km
(Used in L1C-R Product only)

-99 = Missing value (no quality information available)

-100 = Missing scan indicated by QF19¥_SCAN¥_ATMSSDR

-101 = Time sequence error

-102 = Insufficient KAV PRT data

-103 = Insufficient WG PRT data

-104 = Space view antenna position error

-105 = Blackbody view antenna position error

Table 5.2-12 Quality Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Quality	-99	-	-	-	1-byte integer	1 x 96 x nscan1	1	npixel1	nscan1	1

(8) incidenceAngle (4-byte float, array size: nchUIA1 x npixel1 x nscan1)

Earth incidence angle. Values range from 0 to 90 degrees. Special values are defined as:

-9999.9 Missing value

Table 5.2-13 incidenceAngle Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	incidenceAngle	-9999.9	0	90	[degree]	4-byte float	4 x 1 x 96 x nscan1	4	nchUIA1	npixel1	nscan1

(9) sunGlintAngle (1-byte integer, array size: nchUIA1 x npixel1 x nscan1)

Sun glint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees. Sun below horizon value is -88.

-99 Missing value

Table 5.2-14 sunGlintAngle Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	sunGlintAngle	-99	0	127	[degree]	1-byte integer	1 x 1 x 96 x nscan1	1	nchUIA1	npixel1	nscan1

(10) incidenceAngleIndex (1-byte integer, array size: nchannel1 x nscan1)

Values range from 0 to 100. Special values are defined as:

-99 Missing value

Table 5.2-15 incidenceAngleIndex Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	incidenceAngleIndex	-99	0	100	-	1-byte integer	1 x 1 x nscan1	1	nchannel1	nscan1	1

(11) Tc (4-byte float, array size: nchannel1 x npixel1 x nscan1)

GPM Common Calibrated Brightness Temperature. The channels are:

23.8 GHz quasi vertically-polarized TBs

Table 5.2-16 Tc Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Tc	-9999.9	0	10000	[K]	4-byte float	4 x 1 x 96 x nscan1	4	nchannel1	npixel1	nscan1

5.2.2.2 S2 (Swath)

(1) S2_SwathHeader (Metadata)

S2_SwathHeader contains metadata for swaths.

Table 5.2-17 S2_SwathHeader Group

Metadata Element	Estimated Size (bytes)	Description
NumberScansInSet	50	The scans read by TKreadScan are a ”set”. For single swath data, one scan is read so NumberScansInSet=1. For multiple swath data, one TKreadScan may read more than one scan. For example, for SSM/I data one TKreadScan reads one low frequency scan and two high frequency scans. Therefore NumberScansInSet=1 for the low frequency swath and NumberScansInSet=2 for the high frequency swath.
MaximumNumberScansTotal	50	The maximum allowed number of total scans in this swath. Total scans = overlap scans before granule + scans in granule + overlap scans after granule.
NumberScansBeforeGranule	50	The number of overlap scans before the first scan of the granule in this swath.
NumberScansGranule	50	The number of scans in the granule in this swath.
NumberScansAfterGranule	50	The number of overlap scans after the last scan of the granule in this swath.
NumberPixels	50	The number of IFOV in each scan in this swath.
ScanType	50	The type of scan in this swath. Values are: ”CROSSTRACK” and ”CONICAL”

(2) S2_IncidenceAngleIndex (Metadata)

S2_IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array.

Table 5.2-18 S2_IncidenceAngleIndex Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	S2_IncidenceAngleIndex	-99	0	100	-	1-byte integer	1 x 1 x nscan2	1	nchannel2	nscan2	1

(3) ScanTime (Group in S2)

Year (2-byte integer, array size: nscan2)

4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:

-9999 Missing value

Month (1-byte integer, array size: nscan2)

Month of the year. Values range from 1 to 12 months. Special values are defined as:

-99 Missing value

DayOfMonth (1-byte integer, array size: nscan2)

Day of the month. Values range from 1 to 31 days. Special values are defined as:

-99 Missing value

Hour (1-byte integer, array size: nscan2)

UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:

-99 Missing value

Minute (1-byte integer, array size: nscan2)

Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:

-99 Missing value

Second (1-byte integer, array size: nscan2)

Second of the minute. Values range from 0 to 60 s. Special values are defined as:

-99 Missing value

MilliSecond (2-byte integer, array size: nscan2)

Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:

-9999 Missing value

DayOfYear (2-byte integer, array size: nscan2)

Day of the year. Values range from 1 to 366 days. Special values are defined as:

-9999 Missing value

SecondOfDay (8-byte float, array size: nscan2)

A time associated with the scan. scanTime sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:

-9999.9 Missing value

Table 5.2-19 ScanTime Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Year	-9999	1950	2100	[year]	2-byte integer	2 x nscan2	2	nscan2	1	1
2	Month	-99	1	12	[month]	1-byte integer	1 x nscan2	1	nscan2	1	1
3	DayOFMonth	-99	1	31	[day]	1-byte integer	1 x nscan2	1	nscan2	1	1
4	Hour	-99	0	23	[hour]	1-byte integer	1 x nscan2	1	nscan2	1	1
5	Minute	-99	0	59	[minute]	1-byte integer	1 x nscan2	1	nscan2	1	1
6	Second	-99	0	60	[s]	1-byte integer	1 x nscan2	1	nscan2	1	1
7	MilliSecond	-9999	0	999	[ms]	2-byte integer	2 x nscan2	2	nscan2	1	1
8	DayOfYear	-9999	1	366	[day]	2-byte integer	2 x nscan2	2	nscan2	1	1
9	SecoundOfDay	-9999.9	0	86400	[s]	8-byte float	8 x nscan2	8	nscan2	1	1

(4) Latitude (4-byte float, array size: npixel2 x nscan2)

The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:

-9999.9 Missing value

Table 5.2-20 Latitude Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Latitude	-9999.9	-90	90	[degree]	4-byte float	4 x 96 x nscan2	4	npixel2	nscan2	1

(5) Longitude (4-byte float, array size: npixel2 x nscan2)

The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:

-9999.9 Missing value

Table 5.2-21 Longitude Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Longitude	-9999.9	-180	180	[degree]	4-byte float	4 x 96 x nscan2	4	npixel2	nscan2	1

(6) SCstatus (Group in S2)

SCorientation (2-byte integer, array size: nscan2)

The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:

-9999 Missing value

SClatitude (4-byte float, array size: nscan2)

Values range from -90 to 90 degrees. Special values are defined as:

-9999.9 Missing value

SClongitude (4-byte float, array size: nscan2)

Values range from -180 to 180 degrees. Special values are defined as:

-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan2)

Values range from 0 to 1000 km. Special values are defined as:

-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan2)

The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:

-9999.9 Missing value

Table 5.2-22 SCStatus Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	SCorientation	-9999	0	360	[degree]	2-byte integer	2 x nscan2	2	nscan2	1	1
2	SClatitude	-9999.9	-90	90	[degree]	4-byte float	4 x nscan2	4	nscan2	1	1
3	SClongitude	-9999.9	-180	180	[degree]	4-byte float	4 x nscan2	4	nscan2	1	1
4	SCaltitude	-9999.9	0	1000	[km]	4-byte float	4 x nscan2	4	nscan2	1	1
5	FranctionalGranleNumber	-9999.9	0	100000		8-byte float	8 x nscan2	8	nscan2	1	1

(7) Quality (1-byte integer, array size: npixel2 x nscan2)

Quality of Tc in the swath.

GENERAL SPECIFICATIONS

0 = Good data in all channels in the swath

gt 0 = Cautionary warning flags

1-99 = Generic flags (all sensors)

100-127 = Sensor specific flags

lt 0 = Major errors resulting in missing data

-(1-98) = Generic flags (all sensors)

-99 = Missing value (no quality information available)
-(100-127) = Sensor specific flags
DETAILED SPECIFICATIONS
0 = Good data
1 = Possible sun glint
2 = Possible radio frequency interference
3 = Degraded geolocation data
4 = Data corrected for warm load intrusion
-1 = Data is missing from file or unreadable
-2 = Unphysical brightness temperature (Tb lt 50K or 350K gt Tb
-3 = Error in geolocation data
-4 = Data missing in one channel
-5 = Data missing in multiple channels
-6 = Lat/lon values are out of range
-7 = Non-normal status modes
-10 = Distance to corresponding LF pixel > 7 km
(Used in L1C-R Product only)
-99 = Missing value (no quality information available)

Table 5.2-23 Quality Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Quality	-99	-	-	-	1-byte integer	1 x 96 x nscan2	1	npixel2	nscan2	1

(8) incidenceAngle (4-byte float, array size: nchUIA2 x npixel2 x nscan2)

Earth incidence angle. Values range from 0 to 90 degrees. Special values are defined as:

-9999.9 Missing value

Table 5.2-24 incidenceAngle Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	incidenceAngle	-9999.9	0	90	[degree]	4-byte float	4 x 1 x 96 x nscan2	4	nchUIA2	npixel2	nscan2

(9) sunGlintAngle (1-byte integer, array size: nchUIA2 x npixel2 x nscan2):

Sun glint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees. Sun below horizon value is -88.

-99 Missing value

Table 5.2-25 sunGlintAngle Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	sunGlintAngle	-99	0	127	[degree]	1-byte integer	1 x 1 x 96 x nscan2	1	nchUIA2	npixel2	nscan2

(10) incidenceAngleIndex (1-byte integer, array size: nchannel2 x nscan2)

Values range from 0 to 100. Special values are defined as:

-99 Missing value

Table 5.2-26 incidenceAngleIndex Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	incidenceAngleIndex	-99	0	100	-	1-byte integer	1 x 1 x nscan2	1	nchannel2	nscan2	1

(11) Tc (4-byte float, array size: nchannel2 x npixel2 x nscan2)

GPM Common Calibrated Brightness Temperature. The channels are:

31.4 GHz quasi-vertically-polarized TBs

Table 5.2-27 Tc Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Tc	-9999.9	0	10000	[K]	4-byte float	4 x 1 x 96 x nscan2	4	nchannel2	npixel2	nscan2

5.2.2.3 S3 (Swath)

(1) S3_SwathHeader (Metadata)

S3_SwathHeader contains metadata for swaths.

Table 5.2-28 S3_SwathHeader Group

Metadata Element	Estimated Size (bytes)	Description
NumberScansInSet	50	The scans read by TKreadScan are a ”set”. For single swath data, one scan is read so NumberScansInSet=1. For multiple swath data, one TKreadScan may read more than one scan. For example, for SSM/I data one TKreadScan reads one low frequency scan and two high frequency scans. Therefore NumberScansInSet=1 for the low frequency swath and NumberScansInSet=2 for the high frequency swath.
MaximumNumberScansTotal	50	The maximum allowed number of total scans in this swath. Total scans = overlap scans before granule + scans in granule + overlap scans after granule.
NumberScansBeforeGranule	50	The number of overlap scans before the first scan of the granule in this swath.
NumberScansGranule	50	The number of scans in the granule in this swath.
NumberScansAfterGranule	50	The number of overlap scans after the last scan of the granule in this swath.
NumberPixels	50	The number of IFOV in each scan in this swath.
ScanType	50	The type of scan in this swath. Values are: ”CROSSTRACK” and ”CONICAL”

(2) S3_IncidenceAngleIndex (Metadata)

S3_IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array.

Table 5.2-29 S3_IncidenceAngleIndex Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	S3_IncidenceAngleIndex	-99	0	100	-	1-byte integer	1 x 1 x nscan3	1	nchannel3	nscan3	1

(3) ScanTime (Group in S3)

Year (2-byte integer, array size: nscan3)

4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:

-9999 Missing value

Month (1-byte integer, array size: nscan3)

Month of the year. Values range from 1 to 12 months. Special values are defined as:

-99 Missing value

DayOfMonth (1-byte integer, array size: nscan3)

Day of the month. Values range from 1 to 31 days. Special values are defined as:

-99 Missing value

Hour (1-byte integer, array size: nscan3)

UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:

-99 Missing value

Minute (1-byte integer, array size: nscan3)

Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:

-99 Missing value

Second (1-byte integer, array size: nscan3)

Second of the minute. Values range from 0 to 60 s. Special values are defined as:

-99 Missing value

MilliSecond (2-byte integer, array size: nscan3)

Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:

-9999 Missing value

DayOfYear (2-byte integer, array size: nscan3)

Day of the year. Values range from 1 to 366 days. Special values are defined as:

-9999 Missing value

SecondOfDay (8-byte float, array size: nscan3)

A time associated with the scan. scanTime sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:

-9999.9 Missing value

Table 5.2-30 ScanTime Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Year	-9999	1950	2100	[year]	2-byte integer	2 x nscan3	2	nscan3	1	1
2	Month	-99	1	12	[month]	1-byte integer	1 x nscan3	1	nscan3	1	1
3	DayOFMonth	-99	1	31	[day]	1-byte integer	1 x nscan3	1	nscan3	1	1
4	Hour	-99	0	23	[hour]	1-byte integer	1 x nscan3	1	nscan3	1	1
5	Minute	-99	0	59	[minute]	1-byte integer	1 x nscan3	1	nscan3	1	1
6	Second	-99	0	60	[s]	1-byte integer	1 x nscan3	1	nscan3	1	1
7	MilliSecond	-9999	0	999	[ms]	2-byte integer	2 x nscan3	2	nscan3	1	1
8	DayOfYear	-9999	1	366	[day]	2-byte integer	2 x nscan3	2	nscan3	1	1
9	SecoundOfDay	-9999.9	0	86400	[s]	8-byte float	8 x nscan3	8	nscan3	1	1

(4) Latitude (4-byte float, array size: npixel3 x nscan3)

The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:

-9999.9 Missing value

Table 5.2-31 Latitude Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Latitude	-9999.9	-90	90	[degrees]	4-byte float	4 x 96 x nscan3	4	npixel3	nscan3	1

(5) Longitude (4-byte float, array size: npixel3 x nscan3)

The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:

-9999.9 Missing value

Table 5.2-32 Longitude Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Longitude	-9999.9	-180	180	[degrees]	4-byte float	4 x 96 x nscan3	4	npixel3	nscan3	1

(6) SCstatus (Group in S3)

SCorientation (2-byte integer, array size: nscan3)

The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:

-9999 Missing value

SClatitude (4-byte float, array size: nscan3)

Values range from -90 to 90 degrees. Special values are defined as:

-9999.9 Missing value

SClongitude (4-byte float, array size: nscan3)

Values range from -180 to 180 degrees. Special values are defined as:

-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan3)

Values range from 0 to 1000 km. Special values are defined as:

-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan3)

The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:

-9999.9 Missing value

Table 5.2-33 SCStatus Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	SCorientation	-9999	0	360	[degree]	2-byte integer	2 x nscan3	2	nscan3	1	1
2	SClatitude	-9999.9	-90	90	[degree]	4-byte float	4 x nscan3	4	nscan3	1	1
3	SClongitude	-9999.9	-180	180	[degree]	4-byte float	4 x nscan3	4	nscan3	1	1
4	SCaltitude	-9999.9	0	1000	[km]	4-byte float	4 x nscan3	4	nscan3	1	1
5	FranctionalGranleNumber	-9999.9	0	100000		8-byte float	8 x nscan3	8	nscan3	1	1

(7) Quality (1-byte integer, array size: npixel3 x nscan3)

Quality of Tc in the swath.

GENERAL SPECIFICATIONS

0 = Good data in all channels in the swath

gt 0 = Cautionary warning flags

1-99 = Generic flags (all sensors)
100-127 = Sensor specific flags
lt 0 = Major errors resulting in missing data
-(1-98) = Generic flags (all sensors)
-99 = Missing value (no quality information available)
-(100-127) = Sensor specific flags
DETAILED SPECIFICATIONS
0 = Good data
1 = Possible sun glint
2 = Possible radio frequency interference
3 = Degraded geolocation data
4 = Data corrected for warm load intrusion
-1 = Data is missing from file or unreadable
-2 = Unphysical brightness temperature (Tb lt 50K or 350K gt Tb)
-3 = Error in geolocation data
-4 = Data missing in one channel
-5 = Data missing in multiple channels
-6 = Lat/lon values are out of range
-7 = Non-normal status modes
-10 = Distance to corresponding LF pixel > 7 km
(Used in L1C-R Product only)
-99 = Missing value (no quality information available)

Table 5.2-34 Quality Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Quality	-99	-	-	-	1-byte integer	1 x 96 x nscan3	1	npixel3	nscan3	1

(8) incidenceAngle (4-byte float, array size: nchUIA3 x npixel3 x nscan3)

Earth incidence angle. Values range from 0 to 90 degrees. Special values are defined as:

-9999.9 Missing value

Table 5.2-35 incidenceAngle Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	incidenceAngle	-9999.9	0	90	[degree]	4-byte float	4 x 1 x 96 x nscan3	4	nchUIA3	npixel3	nscan3

(9) sunGlintAngle (1-byte integer, array size: nchUIA3 x npixel3 x nscan3)

Sun glint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees. Sun below horizon value is -88.

-99 Missing value

Table 5.2-36 sunGlintAngle Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	sunGlintAngle	-99	0	127	[degree]	1-byte integer	1 x 1 x 96 x nscan3	1	nchUIA3	npixel3	nscan3

(10) incidenceAngleIndex (1-byte integer, array size: nchannel3 x nscan3)

Values range from 0 to 100. Special values are defined as:

-99 Missing value

Table 5.2-37 incidenceAngleIndex Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	incidenceAngleIndex	-99	0	100	-	1-byte integer	1 x 1 x nscan3	1	nchannel3	nscan3	1

(11) Tc (4-byte float, array size: nchannel3 x npixel3 x nscan3)

GPM Common Calibrated Brightness Temperature. The channels are:

88.2 GHz quasi-vertically-polarized TBs

Table 5.2-38 Tc Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Tc	-9999.9	0	10000	[K]	4-byte float	4 x 1 x 96 x nscan3	4	nchannel3	npixel3	nscan3

5.2.2.4 S4 (Swath)

(1) S4_SwathHeader (Metadata)

S4_SwathHeader contains metadata for swaths.

Table 5.2-39 S4_SwathHeader Group

Metadata Element	Estimated Size (bytes)	Description
NumberScansInSet	50	The scans read by TKreadScan are a ”set”. For single swath data, one scan is read so NumberScansInSet=1. For multiple swath data, one TKreadScan may read more than one scan. For example, for SSM/I data one TKreadScan reads one low frequency scan and two high frequency scans. Therefore NumberScansInSet=1 for the low frequency swath and NumberScansInSet=2 for the high frequency swath.
MaximumNumberScansTotal	50	The maximum allowed number of total scans in this swath. Total scans = overlap scans before granule + scans in granule + overlap scans after granule.
NumberScansBeforeGranule	50	The number of overlap scans before the first scan of the granule in this swath.
NumberScansGranule	50	The number of scans in the granule in this swath.
NumberScansAfterGranule	50	The number of overlap scans after the last scan of the granule in this swath.
NumberPixels	50	The number of IFOV in each scan in this swath.
ScanType	50	The type of scan in this swath. Values are: ”CROSSTRACK” and ”CONICAL”

(2) S4_IncidenceAngleIndex (Metadata)

S4_IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array.

Table 5.2-40 S4_IncidenceAngleIndex Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	S4_IncidenceAngleIndex	-99	0	100	-	1-byte integer	1 x 6 x nscan4	1	nchannel4	nscan4	1

(3) ScanTime (Group in S4)

Year (2-byte integer, array size: nscan4)

4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:

-9999 Missing value

Month (1-byte integer, array size: nscan4)

Month of the year. Values range from 1 to 12 months. Special values are defined as:

-99 Missing value

DayOfMonth (1-byte integer, array size: nscan4)

Day of the month. Values range from 1 to 31 days. Special values are defined as:

-99 Missing value

Hour (1-byte integer, array size: nscan4)

UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:

-99 Missing value

Minute (1-byte integer, array size: nscan4)

Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:

-99 Missing value

Second (1-byte integer, array size: nscan4)

Second of the minute. Values range from 0 to 60 s. Special values are defined as:

-99 Missing value

MilliSecond (2-byte integer, array size: nscan4)

Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:

-9999 Missing value

DayOfYear (2-byte integer, array size: nscan4)

Day of the year. Values range from 1 to 366 days. Special values are defined as:

-9999 Missing value

SecondOfDay (8-byte float, array size: nscan4)

A time associated with the scan. scanTime sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:

-9999.9 Missing value

Table 5.2-41 ScanTime Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Year	-9999	1950	2100	[year]	2-byte integer	2 x nscan4	2	nscan4	1	1
2	Month	-99	1	12	[month]	1-byte integer	1 x nscan4	1	nscan4	1	1
3	DayOFMonth	-99	1	31	[day]	1-byte integer	1 x nscan4	1	nscan4	1	1
4	Hour	-99	0	23	[hour]	1-byte integer	1 x nscan4	1	nscan4	1	1
5	Minute	-99	0	59	[minute]	1-byte integer	1 x nscan4	1	nscan4	1	1
6	Second	-99	0	60	[s]	1-byte integer	1 x nscan4	1	nscan4	1	1
7	MilliSecond	-9999	0	999	[ms]	2-byte integer	2 x nscan4	2	nscan4	1	1
8	DayOfYear	-9999	1	366	[day]	2-byte integer	2 x nscan4	2	nscan4	1	1
9	SecoundOfDay	-9999.9	0	86400	[s]	8-byte float	8 x nscan4	8	nscan4	1	1

(4) Latitude (4-byte float, array size: npixel4 x nscan4)

The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:

-9999.9 Missing value

Table 5.2-42 Latitude Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Latitude	-9999.9	-90	90	[degree]	4-byte float	4 x 96 x nscan4	4	npixel4	nscan4	1

(5) Longitude (4-byte float, array size: npixel4 x nscan4)

The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:

-9999.9 Missing value

Table 5.2-43 Longitude Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Longitude	-9999.9	-180	180	[degree]	4-byte float	4 x 96 x nscan4	4	npixel4	nscan4	1

(6) SCstatus (Group in S4)

SCorientation (2-byte integer, array size: nscan4)

The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:

-9999 Missing value

SClatitude (4-byte float, array size: nscan4)

Values range from -90 to 90 degrees. Special values are defined as:

-9999.9 Missing value

SClongitude (4-byte float, array size: nscan4)

Values range from -180 to 180 degrees. Special values are defined as:

-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan4)

Values range from 0 to 1000 km. Special values are defined as:

-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan4)

The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:

-9999.9 Missing value

Table 5.2-44 SCStatus Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	SCorientation	-9999	0	360	[degree]	2-byte integer	2 x nscan4	2	nscan4	1	1
2	SClatitude	-9999.9	-90	90	[degree]	4-byte float	4 x nscan4	4	nscan4	1	1
3	SClongitude	-9999.9	-180	180	[degree]	4-byte float	4 x nscan4	4	nscan4	1	1
4	SCaltitude	-9999.9	0	1000	[km]	4-byte float	4 x nscan4	4	nscan4	1	1
5	FranctionalGranleNumber	-9999.9	0	100000		8-byte float	8 x nscan4	8	nscan4	1	1

(7) Quality (1-byte integer, array size: npixel4 x nscan4)

Quality of Tc in the swath.

GENERAL SPECIFICATIONS:

0 = Good data in all channels in the swath

gt 0 = Cautionary warning flags

1-99 = Generic flags (all sensors)
100-127 = Sensor specific flags
lt 0 = Major errors resulting in missing data
-(1-98) = Generic flags (all sensors)
-99 = Missing value (no quality information available)
-(100-127) = Sensor specific flags
DETAILED SPECIFICATIONS:
0 = Good data
1 = Possible sun glint
2 = Possible radio frequency interference
3 = Degraded geolocation data
4 = Data corrected for warm load intrusion
-1 = Data is missing from file or unreadable
-2 = Unphysical brightness temperature (Tb lt 50K or 350K gt Tb)
-3 = Error in geolocation data
-4 = Data missing in one channel
-5 = Data missing in multiple channels
-6 = Lat/lon values are out of range
-7 = Non-normal status modes
-10 = Distance to corresponding LF pixel > 7 km
(Used in L1C-R Product only)
-99 = Missing value (no quality information available)

Table 5.2-45 Quality Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Quality	-99	-	-	-	1-byte integer	1 x 96 x nscan4	1	npixel4	nscan4	1

(8) incidenceAngle (4-byte float, array size: nchUIA4 x npixel4 x nscan4)

Earth incidence angle. Values range from 0 to 90 degrees. Special values are defined as:

-9999.9 Missing value

Table 5.2-46 incidenceAngle Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	incidenceAngle	-9999.9	0	90	[degree]	4-byte float	4 x 1 x 96 x nscan4	4	nchUIA4	npixel4	nscan4

(9) sunGlintAngle (1-byte integer, array size: nchUIA4 x npixel4 x nscan4)

Sun glint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees. Sun below horizon value is -88.

-99 Missing value

Table 5.2-47 sunGlintAngle Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	sunGlintAngle	-99	0	127	[degree]	1-byte integer	1 x 1 x 96 x nscan4	1	nchUIA4	npixel4	nscan4

(10) incidenceAngleIndex (1-byte integer, array size: nchannel4 x nscan4)

Values range from 0 to 100. Special values are defined as:

-99 Missing value

Table 5.2-48 incidenceAngleIndex Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	incidenceAngleIndex	-99	0	100	-	1-byte integer	1 x 6 x nscan4	1	nchannel4	nscan4	1

(11) Tc (4-byte float, array size: nchannel4 x npixel4 x nscan4)

GPM Common Calibrated Brightness Temperature. The channels are:
165.5 GHz quasi-horizontally-polarized TBs
183.31+-7 GHz quasi-horizontally-polarized TBs
183.31+-4.5 GHz quasi-horizontally-polarized TBs
183.31+-3 GHz quasi-horizontally-polarized TBs
183.31+-1.8 GHz quasi-horizontally-polarized TBs
183.31+-1 GHz quasi-horizontally-polarized TBs

Table 5.2-49 Tc Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Tc	-9999.9	0	10000	[K]	4-byte float	4 x 6 x 96 x nscan4	4	nchannel4	npixel4	nscan4

6. 1CMHS – Common Calibrated Brightness Temperature

6.1. Data Format Structure

6.1.1. Dimension definition

Dimension definitions:

- nscan1
  - var Number of Swath 1 scans in the granule.
- nchannel1
  - 5 Number of Swath 1 channels.
- npixel1
  - 90 Number of Swath 1 pixels in one scan.
- nchUIA1
  - 1 Number of Swath S1 unique incidence angles.

6.1.2. Data Format Structure for 1CMHS – Common Calibrated Brightness Temperature

1CMHS contains common calibrated brightness temperature from the MHS passive microwave instrument flown on the NOAA and METOPS satellites. Swath S1 is the only swath and has 5 channels (89.0GHzV, 157.0GHzV, 183.3GHz+/-250MHzH, 183.3GHz+/- 500MHzH, and 190.3 GHzV). MHS is very similar to AMSU-B. The scan period is 2.667s.

RELATION BETWEEN THE SWATHS: S1 is the only swath, containing observations sampled 90 times along the scan.

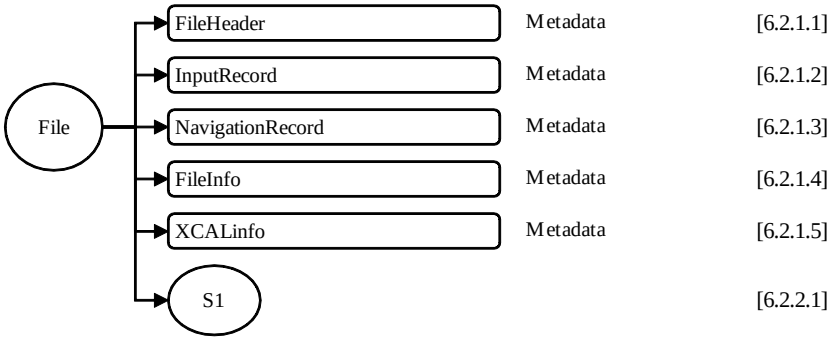

Figure 6.1-1 Data Format Structure for 1CMHS – Common Calibrated Brightness Temperature

6.1.3. Data Format Structure for each Group

6.1.3.1 Data Format Structure for S1 Group

S1 Group's structure is shown in this section.

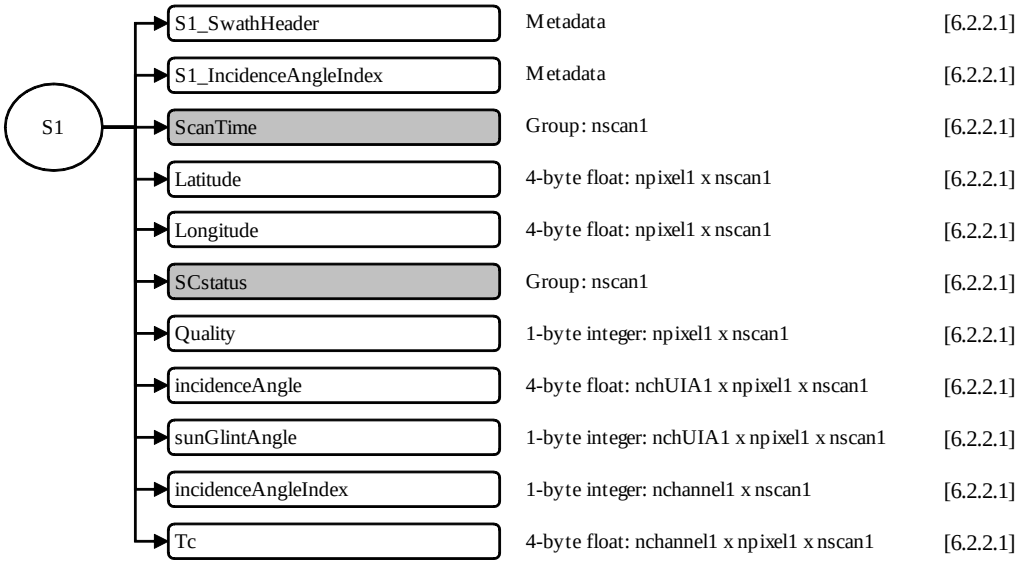

Figure 6.1-2 Data Format Structure for1CMHS, S1

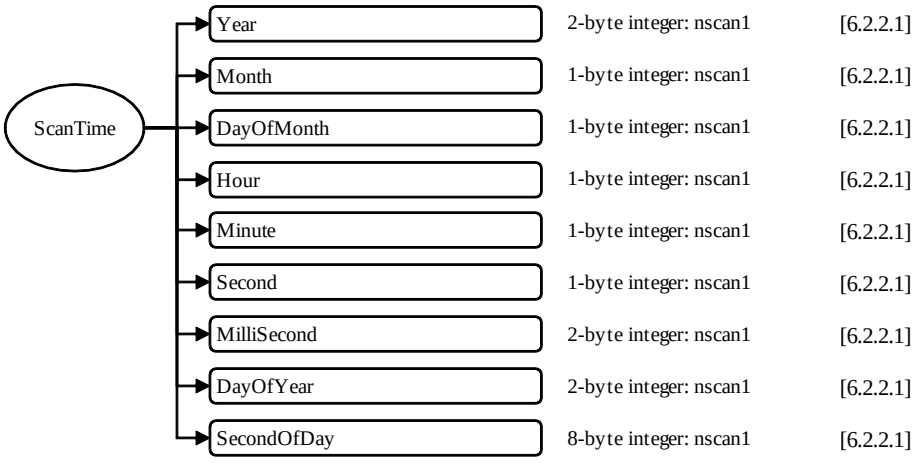

Figure 6.1-3 Data Format Structure for 1CMHS, ScanTime

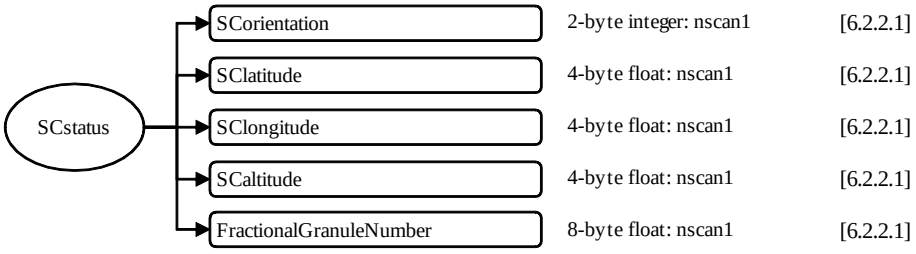

Figure 6.1-4 Data Format Structure for 1CMHS, SCstatus

6.2. Contents of objects in each Group

6.2.1. Metadata

6.2.1.1 FileHeader

FileHeader contains metadata of general interest. Table 6.2-1 shows each metadata elements in FileHeader.

Table 6.2-1 FileHeader Group

Metadata Element	Estimated Size (bytes)	Description
DOI	256	Digital Object Identifier *Value is blank currently
DOIauthority	256	Digital Object Identifier Authority.
DOIshortName	256	Digital Object Identifier Short Name. *Value is blank currently.
AlgorithmID	50	The algorithm that generated this product, e.g., 2A12.
AlgorithmVersion	50	The version of the algorithm that generated this product.
FileName	50	The file name of this granule.
SatelliteName	10	Values are: TRMM GPM MULTI F10 ... F18 AQUA GCOMW1 CORIOLIS MT1 NOAA15 ... NOAA19 METOPANPP. More values will be added as they are known.
InstrumentName	10	Values are: PR TMI VIRS PRTMI KU KA DPR GMI DPRGMI MERGED SSMI SSMIS AMSRE AMSR2 WIND-SAT MADRAS AMSUA AMSUB SAPHIR MHS ATMS. More values will be added as they are known.
GenerationDateTime	50	The date and time this granule was generated. The format is YYYY-MM-DDTHH:MM:SS.sssZ, where YYYY is 4-digit year, MM is month number, DD is day of month, T is ”T”, HH is hour, MM is minute, SS is second, sss is millisecond, and Z is ”Z”. All fields are zero-filled. The missing value is constructed by replacing all digits with 9, i.e., 9999-99-99T99:99:99.999Z
StartGranuleDateTime	50	The start time defining this granule. The format is the same as GenerationDateTime. DETAILS: An orbital granule starts when the satellite is at the position defined by GranuleStart. Thus the start time is not the first scan time. Some algorithms have overlap scans in the file before the start time as defined in SwathHeader. A monthly granule starts on the first ms of the month, for example March 1998 would be 1998-03-01T00:00:00.000Z
StopGranuleDateTime	50	The stop time defining this granule. The format is the same as GenerationDateTime. DETAILS: An orbital granule stops when the satellite is at the position defined by GranuleStart. Thus the stop time is not the last scan time. Some algorithms have overlap scans in the file after the stop time as defined in SwathHeader. A monthly granule stops on the last ms of the month, for example March 1998 would be 1998-03-31T23:59:59.999Z
GranuleNumber	50	The number of this granule, which starts as in GranuleStart. If the GranuleStart is identical to the orbit start, then the GranuleNumber will be the same as the orbit number. The GranuleNumber will have 6 digits, including leading zeroes, for example 001234.
NumberOfSwaths	50	The number of swaths in this granule.
NumberOfGrids	50	The number of grid structures in this granule.
GranuleStart	50	The starting place in the orbit of this granule. Currently defined values are ”SOUTHERNMOST LATITUDE” and ”NORTHBOUND EQUATOR CROSSING”.
TimeInterval	50	The time interval covered by this granule. Values are ”ORBIT”, ”HALF ORBIT”, ”HALF HOUR”, ”HOUR”, ”3 HOUR”, ”DAY”, ”MONTH”, ”CONTACT”.

Metadata Element	Estimated Size (bytes)	Description
ProcessingSystem	50	The name of the processing system, e.g., ”PPS”, ”JAXA”.
ProductVersion	50	The data version assigned by the processing system.
EmptyGranule	50	Whether a granule is empty. Values are ”EMPTY” or ”NOT EMPTY”.
MissingData	50	The number of missing scans.

6.2.1.2 InputRecord

InputRecord contains a record of input files for this granule. Table 6.2-2 shows each metadata elements in InputRecord.

Table 6.2-2 InputRecord Group

Metadata Element	Estimated Size (bytes)	Description
InputFileName	1000	A list of input file names for this granule.
InputAlgorithmVersions	1000	A list of algorithm versions of the input files for this granule.
InputGenerationDatteTimes	1000	A list of generation date times of the input files for this granule. The format is the same as GenerationDateTime.

6.2.1.3 NavigationRecord

NavigationRecord contains navigation metadata for this granule. Table 6.2-3 shows each metadata elements in NavigationRecord.

Table 6.2-3 NavigationRecord Group

Metadata Element	Estimated Size (bytes)	Description
LongitudeOnEquator	50	The longitude where the satellite crosses the equator going from south to north.
UTCDateTimeOnEquator	50	The UTC time when the satellite crosses the equator going from south to north. The format is the same as GenerationDate Time.
MeanSolarBetaAngle	50	The average solar beta angle in this granule.
EphemerisFileName	50	Name of the ephemeris file input for processing.
AttitudeFileName	50	Name of the attitude file input for processing.
GeoControlFileName	50	Name of the GeoTK Control Parameters File input for processing.
EphemerisSource	50	Values are ”0 CONSTANT INPUT TEST VALUE”, ”1 GROUND ESTIMATED STATE (GES)”, ”2 GPS FILTERED SOLUTION (GEONS)”, ”3 GPS POINT SOLUTION (PVT)”, ”4 ON BOARD PROPAGATED (OBP)”, ”5 OEM GROUND EPHEMERIS FILE”, ”6 GEONS WITH FALLBACK AS FLAGGED”, ”7 PVT WITH FALLBACK AS FLAGGED”, ”8 OBP WITH FALLBACK AS FLAGGED”, ”9 GES WITH FALLBACK AS FLAGGED”
AttitudeSource	50	Values are ”0 CONSTANT INPUTS FOR TESTING”, ”1 ON BOARD CALCULATED PITCH ROLL YAW”
GeoToolkitVersion	50	Version of the GeoToolkit
SensorAlignmentFirstRotationAngle	50	Alignment angle, first rotation, in degrees. Rotation adjustment from sensor coordinates to the Attitude Control System Flight Coordinates.
SensorAlignmentSecondRotationAngle	50	Alignment angle, second rotation, in degrees.
SensorAlignmentThirdRotationAngle	50	Alignment angle, third rotation, in degrees.

Metadata Element	Estimated Size (bytes)	Description
SensorAlignmentFirstRotationAxis	50	Euler rotation sequence, first rotation axis. Values are ”1”, ”2”, ”3” (representing X, Y, Z).
SensorAlignmentSecondRotationAxis	50	Euler rotation sequence, second rotation axis. Values are ”1”, ”2”, ”3” (representing X, Y, Z).
SensorAlignmentThirdRotationAxis	50	Euler rotation sequence, third rotation axis. Values are ”1”, ”2”, ”3” (representing X, Y, Z).

6.2.1.4 FileInfo

FileInfo contains metadata used by the PPS I/O Toolkit. Table 6.2-4 shows each metadata elements in FileInfo.

Table 6.2-4 FileInfo Group

Metadata Element	Estimated Size (bytes)	Description
DataFormatVersion	50	The version of the data format used to write this file. This version is separate for each AlgorithmID. The order is: ”a” ”b” ... ”z” ”aa” ”ab” ... ”az” ”ba” ”bb” ...
TKCodeBuildVersion	50	Usually TK CodeBuildVersion is ”1”. If the I/O routines built by TKIO change even though the DataFormatVersion is unchanged, then TK CodeBuildVersion increments to ”2”, ”3”, ... If subsequently DataFormatVersion changes, TKCodeBuildVersion becomes ”1” again.
MetadataVersion	50	The version of metadata used to write this file. This version is separate for each AlgorithmID. The order is: ”a” ”b” ... ”z” ”aa” ”ab” ... ”az” ”ba” ”bb” ...
FormatPackage	50	The underlying format of this granule. Values are ”HDF4”, ”HDF5”, ”NETCDF”, ”TKBINARY”
BlueprintFilename	50	The filename of the primary blueprint file that defined the format used to write this file.
BlueprintVersion	10	The BlueprintVersion of the format definition
TKIOVersion	50	The version of TKIO used to create I/O routines to write this file. TKIOVersion does not define the format used to write this file.
MetadataStyle	50	The style in which the metadata was written, e.g., ”PVL”. ”PVL” means < parameter >=< value >;
EndianType	50	The endian type of the system that wrote this file. Values are ”BIG ENDIAN” and ”LITTLE ENDIAN”.

6.2.1.5 XCALinfo

XCALinfo contains metadata required by 1C intercalibrated files.

Table 6.2-5 XCALinfo Group

Metadata Element	Estimated Size (bytes)	Description
CalibrationStandard	50	The brightness temperature reference standard, e.g., ”cc 1.1”.
CalibrationTable	50	The name of a file containing the calibration table used to make this product, e.g., ”1C.AQUA.ASMRE.XCAL2013-P.tbl”.
CalibrationLevel	50	The level development of the intercalibration for a given sensor. When this level increases for a given sensor the Level 1C files are reprocessed and the version number will also increment. The intercalibration level is defined as follows: N (None): No intercalibration has been applied. Tbs are unchanged from Level 1B source files.

Metadata Element	Estimated Size (bytes)	Description
		P (Preliminary): A preliminary or beta intercalibration has been applied to match the Tb to the reference. V (Verified): The intercalibration has been verified by at least one independent effort. C (Consensus): The XCAL intercalibration has been finalized and accepted by the Science Team.

6.2.2. Data Group

Elements of data group are explained in detail in this section.

6.2.2.1 S1 (Swath)

(1) S1_SwathHeader (Metadata)

S1_SwathHeader contains metadata for swaths.

Table 6.2-6 S1_SwathHeader Group

Metadata Element	Estimated Size (bytes)	Description
NumberScansInSet	50	The scans read by TKreadScan are a ”set”. For single swath data, one scan is read so NumberScansInSet=1. For multiple swath data, one TKreadScan may read more than one scan. For example, for SSM/I data one TKreadScan reads one low frequency scan and two high frequency scans. Therefore NumberScansInSet=1 for the low frequency swath and NumberScansInSet=2 for the high frequency swath.
MaximumNumberScansTotal	50	The maximum allowed number of total scans in this swath. Total scans = overlap scans before granule + scans in granule + overlap scans after granule.
NumberScansBeforeGranule	50	The number of overlap scans before the first scan of the granule in this swath.
NumberScansGranule	50	The number of scans in the granule in this swath.
NumberScansAfterGranule	50	The number of overlap scans after the last scan of the granule in this swath.
NumberPixels	50	The number of IFOV in each scan in this swath.
ScanType	50	The type of scan in this swath. Values are: ”CROSSTRACK” and ”CONICAL”

(2) S1_IncidenceAngleIndex (Metadata)

S1_IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array.

Table 6.2-7 S1_IncidenceSngleIndex Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	S1_IncidenceAngleIndex	-99	0	100	-	1-byte integer	1 x 5 x nscan1	1	nchannel1	nscan1	1

(3) ScanTime (Group in S1)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan1)

4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:

-9999 Missing value

Month (1-byte integer, array size: nscan1)

Month of the year. Values range from 1 to 12 months. Special values are defined as:

-99 Missing value

DayOfMonth (1-byte integer, array size: nscan1)

Day of the month. Values range from 1 to 31 days. Special values are defined as:

-99 Missing value

Hour (1-byte integer, array size: nscan1)

UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:

-99 Missing value

Minute (1-byte integer, array size: nscan1)

Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:

-99 Missing value

Second (1-byte integer, array size: nscan1)

Second of the minute. Values range from 0 to 60 s. Special values are defined as:

-99 Missing value

MilliSecond (2-byte integer, array size: nscan1)

Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:

-9999 Missing value

DayOfYear (2-byte integer, array size: nscan1)

Day of the year. Values range from 1 to 366 days. Special values are defined as:

-9999 Missing value

SecondOfDay (8-byte float, array size: nscan1)

A time associated with the scan. scanTime sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:

-9999.9 Missing value

Table 6.2-8 ScanTime Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Year	-9999	1950	2100	[year]	2-byte integer	2 x nscan1	2	nscan1	1	1
2	Month	-99	1	12	[month]	1-byte integer	1 x nscan1	1	nscan1	1	1
3	DayOFMonth	-99	1	31	[day]	1-byte integer	1 x nscan1	1	nscan1	1	1
4	Hour	-99	0	23	[hour]	1-byte integer	1 x nscan1	1	nscan1	1	1
5	Minute	-99	0	59	[minute]	1-byte integer	1 x nscan1	1	nscan1	1	1
6	Second	-99	0	60	[s]	1-byte integer	1 x nscan1	1	nscan1	1	1
7	MilliSecond	-9999	0	999	[ms]	2-byte integer	2 x nscan1	2	nscan1	1	1
8	DayOfYear	-9999	1	366	[day]	2-byte integer	2 x nscan1	2	nscan1	1	1
9	SecoundOfDay	-9999.9	0	86400	[s]	8-byte float	8 x nscan1	8	nscan1	1	1

(4) Latitude (4-byte float、array size: npix1 x nscan1)

The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:

-9999.9 Missing value

Table 6.2-9 Latitude Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Latitude	-9999.9	-90	90	[degree]	4-byte float	4 x 90 x nscan1	1	npixel1	nscan1	1

(5) Longitude (4-byte float、array size: npix1 x nscan1)

The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:

-9999.9 Missing value

Table 6.2-10 Longitude Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Longitude	-9999.9	-180	180	[degree]	4-byte float	4 x 90 x nscan1	4	npixel1	nscan1	1

(6) SCstatus (Group in S1)

SCorientation (2-byte integer, array size: nscan1)

The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:

-9999 Missing value

SClatitude (4-byte float, array size: nscan1)

Values range from -90 to 90 degrees. Special values are defined as:

-9999.9 Missing value

SClongitude (4-byte float, array size: nscan1)

Values range from -180 to 180 degrees. Special values are defined as:

-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan1)

Values range from 0 to 1000 km. Special values are defined as:

-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan1)

The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:

-9999.9 Missing value

Table 6.2-11 SCStatus Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	SCorientation	-9999	0	360	[degree]	2-byte integer	2 x nscan1	2	nscan1	1	1
2	SClatitude	-9999.9	-90	90	[degree]	4-byte float	4 x nscan1	4	nscan1	1	1
3	SClongitude	-9999.9	-180	180	[degree]	4-byte float	4 x nscan1	4	nscan1	1	1
4	SCaltitude	-9999.9	0	1000	[km]	4-byte float	4 x nscan1	4	nscan1	1	1
5	FranctionalGranleNumber	-9999.9	0	100000		8-byte float	8 x nscan1	8	nscan1	1	1

(7) Quality (1-byte integer, array size: npixel1 x nscan1)

Quality of Tc in the swath.

GENERAL SPECIFICATIONS

0 = Good data in all channels in the swath

gt 0 = Cautionary warning flags

1-99 = Generic flags (all sensors)

100-127 = Sensor specific flags

lt 0 = Major errors resulting in missing data

-(1-98) = Generic flags (all sensors)

-99 = Missing value (no quality information available)

-(100-127) = Sensor specific flags

DETAILED SPECIFICATIONS

0 = Good data

1 = Possible sun glint

2 = Possible radio frequency interference

3 = Degraded geolocation data

4 = Data corrected for warm load intrusion

-1 = Data is missing from file or unreadable

-2 = Unphysical brightness temperature (Tb lt 50K or 350K gt Tb)

-3 = Error in geolocation data

-4 = Data missing in one channel

-5 = Data missing in multiple channels

-6 = Lat/lon values are out of range

-7 = Non-normal status modes

-10 = Distance to corresponding LF pixel > 7 km
(Used in L1C-R Product only)

-99 = Missing value (no quality information available)

Table 6.2-12 Quality Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Quality	-99	-	-	-	1-byte integer	1 x 90 x nscan1	1	npixel1	nscan1	1

(8) incidenceAngle (4-byte float, array size: nchUIA1 x npixel1 x nscan1)

Earth incidence angle. Values range from 0 to 90 degrees. Special values are defined as:

-9999.9 Missing value

Table 6.2-13 incidenceAngle Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	incidenceAngle	-9999.9	0	90	[degree]	4-byte float	4 x 1 x 90 x nscan1	4	nchUIA1	npixel1	nscan1

(9) sunGlintAngle (1-byte integer, array size: nchUIA1 x npixel1 x nscan1)

Sun glint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees. Sun below horizon value is -88.

-99 Missing value

Table 6.2-14 sunGlintAngle Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	sunGlintAngle	-99	0	127	[degree]	1-byte integer	1 x 1 x 90 x nscan1	1	nchUIA1	npixel1	nscan1

(10) incidenceAngleIndex (1-byte integer, array size: nchannel1 x nscan1)

Values range from 0 to 100. Special values are defined as:

-99 Missing value

Table 6.2-15 incidenceAngleIndex Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	incidenceAngleIndex	-99	0	100	-	1-byte integer	1 x 5 x nscan1	1	nchannel1	nscan1	1

(11) Tc (4-byte float, array size: nchannel1 x npixel1 x nscan1)

GPM Common Calibrated Brightness Temperature. The channels are:

89.0 GHz vertically-polarized TBs
157.0 GHz vertically-polarized TBs
183.3 GHz +/-250MHzH horizontally-polarized TBs
183.3 GHz +/-500MHzH horizontally-polarized TBs
190.3 GHz vertically-polarized TBs

Table 6.2-16 Tc Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Tc	-9999.9	0	10000	[K]	4-byte float	4 x 5 x 90 x nscan1	4	nchannel1	npixel1	nscan1

7. 1CSAPHIR – Common Calibrated Brightness Temperature

7.1. Data Format Structure

7.1.1. Dimension definition

Dimension definitions:

- nscan1
  - var Number of Swath 1 scans in the granule.
- nchannel1
  - 6 Number of Swath 1 channels.
- npixel1
  - 182 Number of Swath 1 pixels in one scan.
- nchUIA1
  - 1 Number of Swath S1 unique incidence angles.

7.1.2. Data Format Structure for 1CSAPHIR – Common Calibrated Brightness Temperature

1CSAPHIR contains common calibrated brightness temperature from the SAPHIR passive microwave instrument flown on the Megha-Tropiques satellite. Swath S1 is the only swath and has 6 channels (S1 S2 S3 S4 S5 S6) The channels are 183.1 +/- delta GHz, where delta = 0.2, 1.1, 2.8, 4.2, 6.8, 11.0.

RELATION BETWEEN THE SWATHS: S1 is the only swath, containing observations sampled 182 times along the scan.

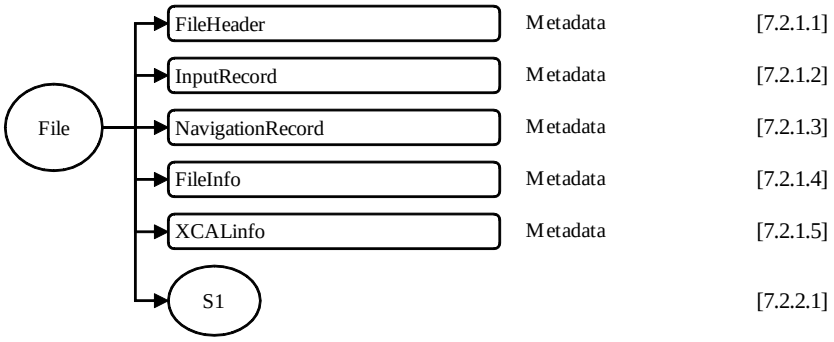

Figure 7.1-1 Data Format Structure for 1CSAPHIR –Common Calibrated Brightness Temperature

7.1.3. Data Format Structure for each Group

7.1.3.1 Data Format Structure for S1 Group

S1 Group's structure is shown in this section.

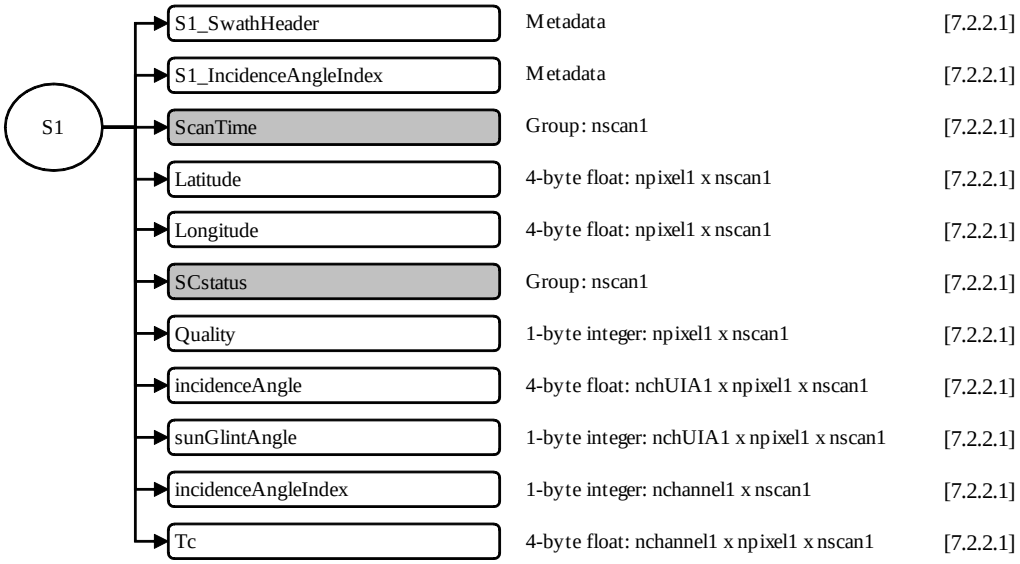

Figure 7.1-2 Data Format Structure for 1CSAPHIR, S1

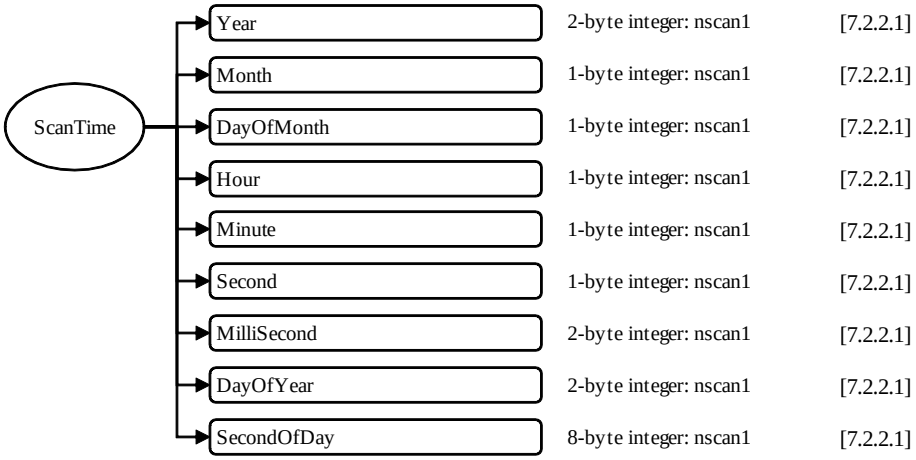

Figure 7.1-3 Data Format Structure for 1CSAPHIR, ScanTime

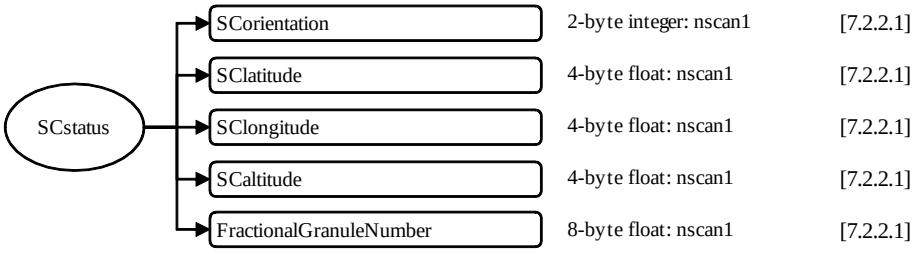

Figure 7.1-4 Data Format Structure for 1CSAPHIR, SCstatus

7.2. Contents of objects in each Group

7.2.1. Metadata

7.2.1.1 FileHeader

FileHeader contains metadata of general interest. Table 7.2-1 shows each metadata elements in FileHeader.

Table 7.2-1 FileHeader Group

Metadata Element	Estimated Size (bytes)	Description
DOI	256	Digital Object Identifier *Value is blank currently
DOIauthority	256	Digital Object Identifier Authority.
DOIshortName	256	Digital Object Identifier Short Name. *Value is blank currently.
AlgorithmID	50	The algorithm that generated this product, e.g., 2A12.
AlgorithmVersion	50	The version of the algorithm that generated this product.
FileName	50	The file name of this granule.
SatelliteName	10	Values are: TRMM GPM MULTI F10 ... F18 AQUA GCOMW1 CORIOLIS MT1 NOAA15 ... NOAA19 METOPANPP. More values will be added as they are known.
InstrumentName	10	Values are: PR TMI VIRS PRTMI KU KA DPR GMI DPRGMI MERGED SSMI SSMIS AMSRE AMSR2 WIND-SAT MADRAS AMSUA AMSUB SAPHIR MHS ATMS. More values will be added as they are known.
GenerationDateTime	50	The date and time this granule was generated. The format is YYYY-MM-DDTHH:MM:SS.sssZ, where YYYY is 4-digit year, MM is month number, DD is day of month, T is ”T”, HH is hour, MM is minute, SS is second, sss is millisecond, and Z is ”Z”. All fields are zero-filled. The missing value is constructed by replacing all digits with 9, i.e., 9999-99-99T99:99:99.999Z
StartGranuleDateTime	50	The start time defining this granule. The format is the same as GenerationDateTime. DETAILS: An orbital granule starts when the satellite is at the position defined by GranuleStart. Thus the start time is not the first scan time. Some algorithms have overlap scans in the file before the start time as defined in SwathHeader. A monthly granule starts on the first ms of the month, for example March 1998 would be 1998-03-01T00:00:00.000Z
StopGranuleDateTime	50	The stop time defining this granule. The format is the same as GenerationDateTime. DETAILS: An orbital granule stops when the satellite is at the position defined by GranuleStart. Thus the stop time is not the last scan time. Some algorithms have overlap scans in the file after the stop time as defined in SwathHeader. A monthly granule stops on the last ms of the month, for example March 1998 would be 1998-03-31T23:59:59.999Z
GranuleNumber	50	The number of this granule, which starts as in GranuleStart. If the GranuleStart is identical to the orbit start, then the GranuleNumber will be the same as the orbit number. The GranuleNumber will have 6 digits, including leading zeroes, for example 001234.
NumberOfSwaths	50	The number of swaths in this granule.
NumberOfGrids	50	The number of grid structures in this granule.
GranuleStart	50	The starting place in the orbit of this granule. Currently defined values are ”SOUTHERNMOST LATITUDE” and ”NORTHBOUND EQUATOR CROSSING”.
TimeInterval	50	The time interval covered by this granule. Values are ”ORBIT”, ”HALF ORBIT”, ”HALF HOUR”, ”HOUR”, ”3 HOUR”, ”DAY”, ”MONTH”, ”CONTACT”.

Metadata Element	Estimated Size (bytes)	Description
ProcessingSystem	50	The name of the processing system, e.g., ”PPS”, ”JAXA”.
ProductVersion	50	The data version assigned by the processing system.
EmptyGranule	50	Whether a granule is empty. Values are ”EMPTY” or ”NOT EMPTY”.
MissingData	50	The number of missing scans.

7.2.1.2 InputRecord

InputRecord contains a record of input files for this granule. Table 7.2-2 shows each metadata elements in InputRecord.

Table 7.2-2 InputRecord Group

Metadata Element	Estimated Size (bytes)	Description
InputFileName	1000	A list of input file names for this granule.
InputAlgorithmVersions	1000	A list of algorithm versions of the input files for this granule.
InputGenerationDatteTimes	1000	A list of generation date times of the input files for this granule. The format is the same as GenerationDateTime.

7.2.1.3 NavigationRecord

NavigationRecord contains navigation metadata for this granule. Table 7.2-3 shows each metadata elements in NavigationRecord.

Table 7.2-3 NavigationRecord Group

Metadata Element	Estimated Size (bytes)	Description
LongitudeOnEquator	50	The longitude where the satellite crosses the equator going from south to north.
UTCDateTimeOnEquator	50	The UTC time when the satellite crosses the equator going from south to north. The format is the same as GenerationDate Time.
MeanSolarBetaAngle	50	The average solar beta angle in this granule.
EphemerisFileName	50	Name of the ephemeris file input for processing.
AttitudeFileName	50	Name of the attitude file input for processing.
GeoControlFileName	50	Name of the GeoTK Control Parameters File input for processing.
EphemerisSource	50	Values are ”0 CONSTANT INPUT TEST VALUE”, ”1 GROUND ESTIMATED STATE (GES)”, ”2 GPS FILTERED SOLUTION (GEONS)”, ”3 GPS POINT SOLUTION (PVT)”, ”4 ON BOARD PROPAGATED (OBP)”, ”5 OEM GROUND EPHEMERIS FILE”, ”6 GEONS WITH FALLBACK AS FLAGGED”, ”7 PVT WITH FALLBACK AS FLAGGED”, ”8 OBP WITH FALLBACK AS FLAGGED”, ”9 GES WITH FALLBACK AS FLAGGED”
AttitudeSource	50	Values are ”0 CONSTANT INPUTS FOR TESTING”, ”1 ON BOARD CALCULATED PITCH ROLL YAW”
GeoToolkitVersion	50	Version of the GeoToolkit
SensorAlignmentFirstRotationAngle	50	Alignment angle, first rotation, in degrees. Rotation adjustment from sensor coordinates to the Attitude Control System Flight Coordinates.
SensorAlignmentSecondRotationAngle	50	Alignment angle, second rotation, in degrees.
SensorAlignmentThirdRotationAngle	50	Alignment angle, third rotation, in degrees.

Metadata Element	Estimated Size (bytes)	Description
SensorAlignmentFirstRotationAxis	50	Euler rotation sequence, first rotation axis. Values are ”1”, ”2”, ”3” (representing X, Y, Z).
SensorAlignmentSecondRotationAxis	50	Euler rotation sequence, second rotation axis. Values are ”1”, ”2”, ”3” (representing X, Y, Z).
SensorAlignmentThirdRotationAxis	50	Euler rotation sequence, third rotation axis. Values are ”1”, ”2”, ”3” (representing X, Y, Z).

7.2.1.4 FileInfo

FileInfo contains metadata used by the PPS I/O Toolkit. Table 7.2-4 shows each metadata elements in FileInfo.

Table 7.2-4 FileInfo Group

Metadata Element	Estimated Size (bytes)	Description
DataFormatVersion	50	The version of the data format used to write this file. This version is separate for each AlgorithmID. The order is: ”a” ”b” ... ”z” ”aa” ”ab” ... ”az” ”ba” ”bb” ...
TKCodeBuildVersion	50	Usually TK CodeBuildVersion is ”1”. If the I/O routines built by TKIO change even though the DataFormatVersion is unchanged, then TK CodeBuildVersion increments to ”2”, ”3”, ... If subsequently DataFormatVersion changes, TKCodeBuildVersion becomes ”1” again.
MetadataVersion	50	The version of metadata used to write this file. This version is separate for each AlgorithmID. The order is: ”a” ”b” ... ”z” ”aa” ”ab” ... ”az” ”ba” ”bb” ...
FormatPackage	50	The underlying format of this granule. Values are ”HDF4”, ”HDF5”, ”NETCDF”, ”TKBINARY”
BlueprintFilename	50	The filename of the primary blueprint file that defined the format used to write this file.
BlueprintVersion	10	The BlueprintVersion of the format definition
TKIOVersion	50	The version of TKIO used to create I/O routines to write this file. TKIOVersion does not define the format used to write this file.
MetadataStyle	50	The style in which the metadata was written, e.g., ”PVL”. ”PVL” means < parameter >=< value >;
EndianType	50	The endian type of the system that wrote this file. Values are ”BIG ENDIAN” and ”LITTLE ENDIAN”.

7.2.1.5 XCALinfo

XCALinfo contains metadata required by 1C intercalibrated files.

Table 7.2-5 XCALinfo Group

Metadata Element	Estimated Size (bytes)	Description
CalibrationStandard	50	The brightness temperature reference standard, e.g., ”cc 1.1”.
CalibrationTable	50	The name of a file containing the calibration table used to make this product, e.g., ”1C.AQUA.ASMRE.XCAL2013-P.tbl”.
CalibrationLevel	50	The level development of the intercalibration for a given sensor. When this level increases for a given sensor the Level 1C files are reprocessed and the version number will also increment. The intercalibration level is defined as follows: N (None): No intercalibration has been applied. Tbs are unchanged from Level 1B source files.

Metadata Element	Estimated Size (bytes)	Description
		P (Preliminary): A preliminary or beta intercalibration has been applied to match the Tb to the reference. V (Verified): The intercalibration has been verified by at least one independent effort. C (Consensus): The XCAL intercalibration has been finalized and accepted by the Science Team.

7.2.2. Data Group

Elements of data group are explained in detail in this section.

7.2.2.1 S1 (Swath)

(1) S1_SwathHeader (Metadata)

S1_SwathHeader contains metadata for swaths.

Table 7.2-6 S1_SwathHeader Group

Metadata Element	Estimated Size (bytes)	Description
NumberScansInSet	50	The scans read by TKreadScan are a ”set”. For single swath data, one scan is read so NumberScansInSet=1. For multiple swath data, one TKreadScan may read more than one scan. For example, for SSM/I data one TKreadScan reads one low frequency scan and two high frequency scans. Therefore NumberScansInSet=1 for the low frequency swath and NumberScansInSet=2 for the high frequency swath.
MaximumNumberScansTotal	50	The maximum allowed number of total scans in this swath. Total scans = overlap scans before granule + scans in granule + overlap scans after granule.
NumberScansBeforeGranule	50	The number of overlap scans before the first scan of the granule in this swath.
NumberScansGranule	50	The number of scans in the granule in this swath.
NumberScansAfterGranule	50	The number of overlap scans after the last scan of the granule in this swath.
NumberPixels	50	The number of IFOV in each scan in this swath.
ScanType	50	The type of scan in this swath. Values are: ”CROSSTRACK” and ”CONICAL”

(2) S1_IncidenceAngleIndex (Metadata)

S1_IncidenceAngleIndex contains a list of indeces of the incidence angle array and sun glint angle array.

Table 7.2-7 S1_IncidenceAngleIndex Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	S1_IncidenceAngleIndex	-99	0	100	-	1-byte integer	1 x 6 x nscan1	1	nchannel1	nscan1	1

(3) ScanTime (Group)

A UTC time associated with the scan.

Year (2-byte integer, array size: nscan1)

4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:

-9999 Missing value

Month (1-byte integer, array size: nscan1)

Month of the year. Values range from 1 to 12 months. Special values are defined as:

-99 Missing value

DayOfMonth (1-byte integer, array size: nscan1)

Day of the month. Values range from 1 to 31 days. Special values are defined as:

-99 Missing value

Hour (1-byte integer, array size: nscan1)

UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:

-99 Missing value

Minute (1-byte integer, array size: nscan1)

Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:

-99 Missing value

Second (1-byte integer, array size: nscan1)

Second of the minute. Values range from 0 to 60 s. Special values are defined as:

-99 Missing value

MilliSecond (2-byte integer, array size: nscan1)

Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:

-9999 Missing value

DayOfYear (2-byte integer, array size: nscan1)

Day of the year. Values range from 1 to 366 days. Special values are defined as:

-9999 Missing value

SecondOfDay (8-byte float, array size: nscan1)

A time associated with the scan. scanTime sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:

-9999.9 Missing value

Table 7.2-8 ScanTime Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Year	-9999	1950	2100	[year]	2-byte integer	2 x nscan1	2	nscan1	1	1
2	Month	-99	1	12	[month]	1-byte integer	1 x nscan1	1	nscan1	1	1
3	DayOFMonth	-99	1	31	[day]	1-byte integer	1 x nscan1	1	nscan1	1	1
4	Hour	-99	0	23	[hour]	1-byte integer	1 x nscan1	1	nscan1	1	1
5	Minute	-99	0	59	[minute]	1-byte integer	1 x nscan1	1	nscan1	1	1
6	Second	-99	0	60	[s]	1-byte integer	1 x nscan1	1	nscan1	1	1
7	MilliSecond	-9999	0	999	[ms]	2-byte integer	2 x nscan1	2	nscan1	1	1
8	DayOfYear	-9999	1	366	[day]	2-byte integer	2 x nscan1	2	nscan1	1	1
9	SecoundOfDay	-9999.9	0	86400	[s]	8-byte float	8 x nscan1	8	nscan1	1	1

(4) Latitude (4-byte float, array size: npixel1 x nscan1)

The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:

-9999.9 Missing value

Table 7.2-9 Latitude Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Latitude	-9999.9	-90	90	[degree]	4-byte float	4 x 182 x nscan1	4	npixel1	nscan1	1

(5) Longitude (4-byte float, array size: npixel1 x nscan1)

The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:

-9999.9 Missing value

Table 7.2-10 Longitude Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Longitude	-9999.9	-180	180	[degree]	4-byte float	4 x 182 x nscan1	4	npixel1	nscan1	1

(6) SCstatus (Group)

SCorientation (2-byte integer, array size: nscan1)

The angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. The relationship of v to the sensor geometry is defined in the introduction to this algorithm. Values range from 0 to 360 degrees. Special values are defined as:

-9999 Missing value

SClatitude (4-byte float, array size: nscan1)

Values range from -90 to 90 degrees. Special values are defined as:

-9999.9 Missing value

SClongitude (4-byte float, array size: nscan1)

Values range from -180 to 180 degrees. Special values are defined as:

-9999.9 Missing value

SCaltitude (4-byte float, array size: nscan1)

Values range from 0 to 1000 km. Special values are defined as:

-9999.9 Missing value

FractionalGranuleNumber (8-byte float, array size: nscan1)

The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:

-9999.9 Missing value

Table 7.2-11 SCStatus Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	SCorientation	-9999	0	360	[degree]	2-byte integer	2 x nscan1	2	nscan1	1	1
2	SClatitude	-9999.9	-90	90	[degree]	4-byte float	4 x nscan1	4	nscan1	1	1
3	SClongitude	-9999.9	-180	180	[degree]	4-byte float	4 x nscan1	4	nscan1	1	1
4	SCaltitude	-9999.9	0	1000	[km]	4-byte float	4 x nscan1	4	nscan1	1	1
5	FranctionalGranleNumber	-9999.9	0	100000		8-byte float	8 x nscan1	8	nscan1	1	1

(7) Quality (1-byte integer, array size: npixel1 x nscan1)

Quality of Tc in the swath.

GENERAL SPECIFICATIONS:

0 = Good data in all channels in the swath
gt 0 = Cautionary warning flags
1-99 = Generic flags (all sensors)
100-127 = Sensor specific flags
lt 0 = Major errors resulting in missing data
-(1-98) = Generic flags (all sensors)
-99 = Missing value (no quality information available)
-(100-127) = Sensor specific flags

DETAILED SPECIFICATIONS:

0 = Good data
1 = Possible sun glint
2 = Possible radio frequency interference
3 = Degraded geolocation data
4 = Data corrected for warm load intrusion
101 = Backward scanning
-1 = Data is missing from file or unreadable
-2 = Unphysical brightness temperature (Tb lt 50K or 350K gt Tb)
-3 = Error in geolocation data
-4 = Data missing in one channel
-5 = Data missing in multiple channels
-6 = Lat/lon values are out of range
-7 = Non-normal status modes
-10 = Distance to corresponding LF pixel > 7 km
(Used in L1C-R Product only)
-99 = Missing value (no quality information available)
-100 = Invalid scan
-101 = Scan error
-102 = date/time error
-103 = PRT error
-104 = CRC error
-105 = Payload not nominal
-110 = Channel is off
-111 = L0 count saturated or has poor value
-112 = Hot/cold count not available
-113 = Calibration issue

Table 7.2-12 Quality Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Quality	-99	-	-	-	1-byte integer	1 x 182 x nscan1	1	npixel1	nscan1	1

(8) incidenceAngle (4-byte float, array size: nchUIA1 x npixel1 x nscan1)

Earth incidence angle. Values range from 0 to 90 degrees. Special values are defined as:

-9999.9 Missing value

Table 7.2-13 incidenceAngle Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	incidenceAngle	-9999.9	0	90	[degree]	4-byte float	4 x 1 x 182 x nscan1	4	nchUIA1	npixel1	nscan1

(9) sunGlintAngle (1-byte integer, array size: nchUIA1 x npixel1 x nscan1)

Sun glint angle. Angles greater than 127 degrees are set to 127. Values range from 0 to 127 degrees. Sun below horizon value is -88.

-99 Missing value

Table 7.2-14 sunGlintAngle Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	sunGlintAngle	-99	0	127	[degree]	1-byte integer	1 x 1 x 182 x nscan1	1	nchUIA1	npixel1	nscan1

(10) incidenceAngleIndex (1-byte integer, array size: nchannel1 x nscan1)

Values range from 0 to 100. Special values are defined as:

-99 Missing value

Table 7.2-15 incidenceAngleIndex Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	incidenceAngleIndex	-99	0	100	-	1-byte integer	1 x 6 x nscan1	1	nchannel1	nscan1	1

(11) Tc (4-byte float, array size: nchannel1 x npixel1 x nscan1)

GPM Common Calibrated Brightness Temperature. The channels are:

(S1 S2 S3 S4 S5 S6)

183.1 +/- delta GHz, where

delta = 0.2, 1.1, 2.8, 4.2, 6.8, 11.0.

Table 7.2-16 Tc Elements

No.	Element	Missing	Min	Max	unit	type	Data size (byte)	type	array		
1	Tc	-9999.9	0	10000	[K]	4-byte float	4 x 6 x 182 x nscan1	4	nchannel1	npixel1	nscan1

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