LSDS-280
Version 7.0

Department of the Interior
U.S. Geological Survey

LANDSAT THEMATIC MAPPER (TM)
LEVEL 0 REFORMATTED PRODUCT (L0Rp)
DATA FORMAT CONTROL BOOK (DFCB)

Version 7.0

July 2018

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Executive Summary

This document is the Data Format Control Book (DFCB) for the Landsat Thematic Mapper (TM) Level Zero Reformatted Product (L0Rp). It focuses on the Hierarchical Data Format (HDF) of the Landsat TM L0Rp available from the U.S. Geological Survey (USGS) Center for Earth Resources Observation and Science (EROS) Landsat Archive Manager (LAM). HDF, a self-describing format, allows Landsat L0Rp data to be shared across different computer platforms without modification and is supported by a public domain software library consisting of access tools and various utilities.

The Landsat TM product contains the image data and all the ancillary data required to perform radiometric and geometric corrections. The Landsat TM product also includes a Calibration Parameter File (CPF) generated by the Landsat Image Assessment System (IAS). The CPF provides users with enhanced processing parameters for producing rectified image data of superior quality.

This DFCB is under Landsat Operations and Sustaining (O&S) Configuration Control Board (CCB) and may be updated by a Change Request (CR). Comments and questions regarding this document should be directed to:

Landsat Project
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Sioux Falls, SD 57198

Document History

Document Number	Document Version	Publication Date	Change Number
LS-DFCB-12	Version 1.0	May 2005	LCCR 281
LS-DFCB-12	Version 2.0	August 2005	LCCR 285
LS-DFCB-12	Version 3.0	April 2007	LCCR 360
LS-DFCB-12	Version 4.0	May 2007	LCCR 348
LS-DFCB-12	Version 5.0	May 2012	DCR 548
LSDS-280	Version 6.0	March 2016	CR 9203
LSDS-280	Version 7.0	July 2018	CR13606

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Section 1 Introduction

This document is the Data Format Control Book (DFCB) for the Landsat Thematic Mapper (TM) Level 0 Reformatted Product (L0Rp) data. It focuses on the Hierarchical Data Format (HDF) of the TM L0Rp.

1.1 Product Overview

The L0Rp data product is essentially in a raw data form that is marginally useful prior to radiometric and geometric correction. A TM L0Rp data product, however, does contain all of the ancillary data required to perform these corrections.

The L0Rp TM data product is packaged in HDF, which is an open standard selected by the National Aeronautics and Space Administration (NASA) for Earth Observing System (EOS) data products. HDF is a self-describing format that allows an application to interpret the structure and contents of a file without outside information. HDF allows Landsat L0Rp data to be shared across different computer platforms without modification and is supported by a public domain software library consisting of access tools and various utilities.

1.2 Purpose

This DFCB provides the user with a high-level description of the TM L0Rp data, the HDF structuring mechanisms employed, and a detailed layout of the image and ancillary data formats.

The L0Rp format described in this DFCB is also a potential candidate for use as the format for data interchange between International Ground Stations (IGSs) and as a downloadable product from the Level 1 Product Generation System (LPGS). This DFCB explicitly describes the L0Rp data created by the U.S., but is flexible in its treatment of certain data fields that are potentially unique to the U.S. processing approach. These fields exist in both the binary and metadata files and are flagged with a unique fill value. The intent is to facilitate data interchange by defining an L0Rp data format that is easier for the IGS community to use and implement.

Section 2 Product Types

Three sizing options, depicted in Figure 2-1, are available when defining the size or spatial extent of a Landsat L0Rp data.

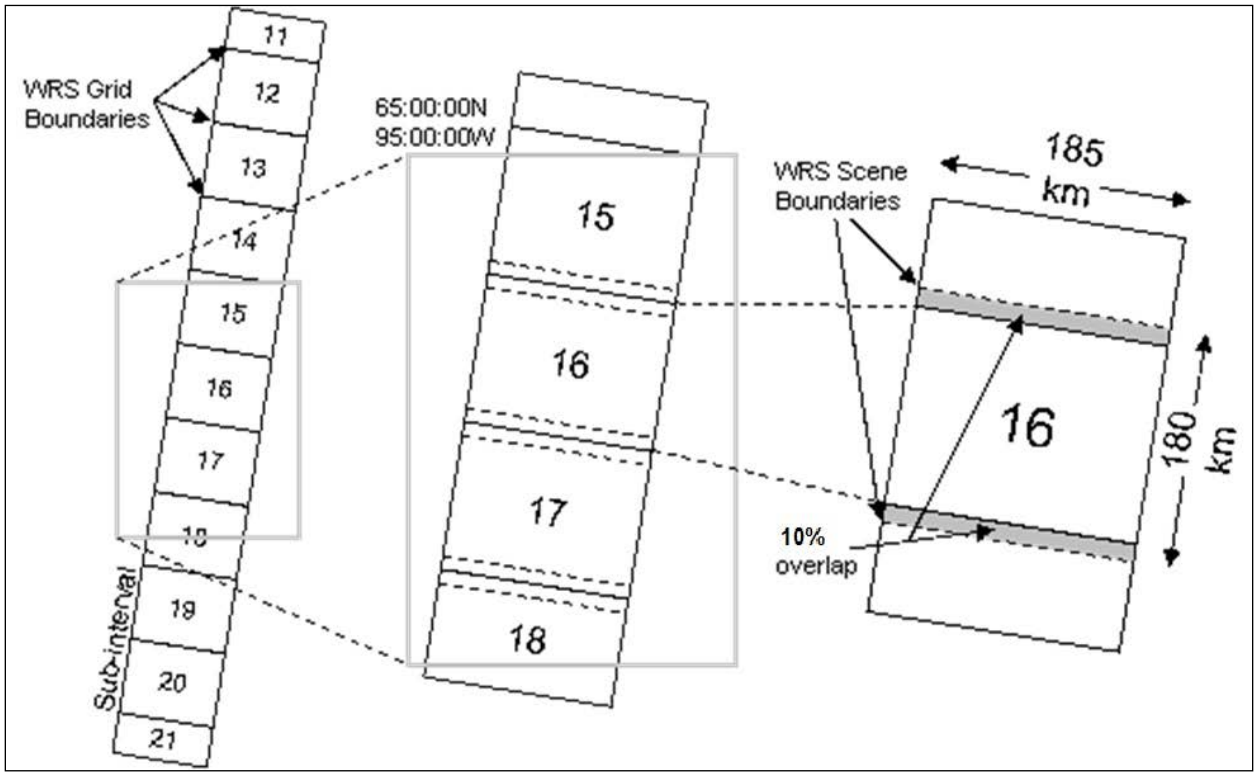

Figure 2-1. L0Rp Data Type

2.1 Standard Worldwide Reference System (WRS) Scene

The WRS indexes orbits (paths) and scene centers (rows) into a global grid system comprising 233 paths by 248 rows. The path/row notation was originally employed to provide a standard designator for every nominal scene center and to allow straightforward referencing without using longitude and latitude coordinates.

The distance between WRS center points along a path is 161.1 kilometers (km). A path distance of 90 km before and after a WRS center point defines the standard scene length or ground distance of 180 km. The standard WRS scene overlaps neighboring scenes along a path by approximately five percent and has a width or cross-track distance of 185 km. Standard WRS scenes have 375 scans.

TM L0Rp data are comprised of one WRS scene.

Section 3 Product Content Overview

A complete scene-sized L0Rp data set consists of data sets derived from the wideband telemetry. A number of files make up the product. The Thematic Mapper – Raw Format (TM-R) L0Rp data set consists of 17 files and the Thematic Mapper – Archive Format (TM-A) data set consists of 20 files. These files include seven image files, an internal Calibration Data (CAL) file, Mirror Scan Correction Data (MSCD) file, Payload Correction Data (PCD) file, Scan Line Offset (SLO) file, two metadata files (Metadata (MTA) and Distribution Product Metadata (MTP)), Geolocation Index (GEO) file, the HDF directory information, ancillary data (ANC), an annotation (ANN) file, a Calculated Gains and Biases (CGB) file, a header (HDR) file, and a CPF and README file (included as part of the LPGS Level 0 Reformatted (L0R) product). Not all TM formats have all files listed. A brief description of each follows.

1–7. Earth Image Data. The unique bands of TM image data comprise seven of the data sets. The data are laid out in a scan line sequential format in descending detector order. Table 3-1 lists individual band characteristics.

Band Number	Wavelength (µm)	Resolution (meters)	Data Lines per Scan	Data Line Length (bytes)	Bits per Sample
1	.450–.515	30	16	6,600	8
2	.525–.605	30	16	6,600	8
3	.630–.690	30	16	6,600	8
4	.775–.900	30	16	6,600	8
5	1.550–1.750	30	16	6,600	8
6	10.40–12.50	120	4	1,650	8
7	2.08–2.35	30	16	6,600	8

Table 3-1. TM Band Characteristics

8. Internal Calibrator Data (CAL). (TM-R Format) CAL consists of scan line ordered internal lamp and shutter data for Band 1 through Band 7, and blackbody radiance and shutter data for Band 6. The data are collected once per scan and structured in a band sequential format in descending detector order (e.g., detector 16 followed by detector 15 and so on for the 30-meter bands).

9. Mirror Scan Correction Data (MSCD). A logical record of MSCD exists for each data scan present in the L0Rp data ordered. Each logical record consists of three MSCD data values—the first half scan error, the second half scan error, and the scan line direction. This information, which applies to the previous scan, computes deviations from nominal scan mirror profiles as measured on the ground and reported in the CPF. Also included in the MSD file are scan-based values such as time code, gain status, and processing errors encountered by Level 0 processing systems. The MSCD are trimmed to fit the product ordered, although one additional record is added to the file during the subsetting process because scan error and direction information corresponds to the previous scan.

10. Payload Correction Data (PCD). The PCD consists of attitude and ephemeris profiles as well as high-frequency jitter measurements. The PCD for the entire interval is included with U.S. generated L0Rp data. At a minimum, the PCD included covers the time of the imagery plus at least an additional 6 seconds before and 18 seconds after the imagery start and stop times, respectively (unless limited by the boundaries of the PCD in the interval).

11. Scan Line Offsets (SLO). The image data within an image file are shifted in an extended buffer to account for predetermined detector and band shifts, scan line length, and possible bumper wear. The SLO represent the actual starting and ending pixel positions for valid (nonzero fill) Earth image data on a data-line-by-data-line basis for Band 1 through Band 7. The left starting pixel offsets also apply to the International Cooperator (IC) data. The right starting pixel offsets for the Earth image and IC data differ, and are reported separately.

12. Metadata Interval (MTA). The MTA characterize the interval's spatial extent, content, and data quality for Band 1 through Band 7. This file, in its entirety and original form, accompanies the L0Rp data.

13. Metadata Product (MTP). A second metadata file contains product-specific information, such as corner coordinates and the number of scans.

14. Geolocation Index (GEO). The GEO is a table containing scene corner coordinates and their product-specific scan line numbers for both band resolutions. Its purpose is to provide efficient subsetting of an L0Rp data set.

15. Calibration Parameter File (CPF). The IAS regularly updates the CPF to reflect changing radiometric and geometric parameters required for Level 1 processing. These CPFs are stamped with applicability dates and bundled with outbound L0Rp data by LPGS.

16. HDF Directory. The HDF directory is a file containing all of the pointers, file size information, and data objects required to open and process the L0Rp data using the HDF library and interface routines.

17. Annotation File (ANN). (TM-A format) The annotation file contains the tic marks required for mapping scene-based u,v coordinates to projection space. This is an American Standard Code for Information Interchange (ASCII) Object Description Language (ODL) file.

18. Ancillary Data (ANC). (TM-A format) The ancillary file contains grid information describing the geometric corrections applied. It also includes general information about the state of the satellite (e.g., scene center ephemeris). This is an ASCII ODL file.

19. Header File (HDR). (TM-A format) The header file contains an extensive list of attitude and ephemeris information as well as radiometric corrections and scan information.

20. Calculated Gains and Biases (CGB). (TM-A format) The CGB file contains the following values for each line in the scene: lamp quality, computed lamp state, computed lamp value, gain, bias, applied gain, and applied bias. These values are associated with the respective lines within the image files.

21. README File. The README file is an ASCII text file that contains general information about the product, the files included, links to additional information and documentation, and Landsat Customer Services contact information.

Section 4 Data Definition

4.1 HDF Conventions

4.1.1 File Structure

The L0Rp data files are created using the HDF function library developed by the National Center for Supercomputing Applications (NCSA). The product's design allows users to choose either low- or high-level programming tools from NCSA's HDF libraries. The product design does not preclude a user from developing original code for product access. All files are simple byte streams. There are no data records as such. Information about the basic structure of HDF files is included in various NCSA and NASA publications (see the References section). The L0Rp data are baselined with HDF version 4.1r4.

New users should begin with the Getting Started with HDF section of the HDF User's Guide, which provides an introduction to the concepts used in HDF file design and programming, and gives the reader an appreciation for the design philosophy of the HDF software and file structure. Additionally, the HDF User's Guide and HDF Reference Manual are excellent resources for the HDF programmer. More advanced users can read the NCSA HDF Specifications and Developer's Guide to learn about the low-level structure of HDF files (see References section for more details).

4.1.2 Data Definition Terminology

Data structures are referred to using HDF terminology. Descriptions of structures relevant to the L0Rp data include:

Scientific Data Set (SDS) — An array of data of any fixed dimensionality (rank) from 1 to 32767 and any one data type.

Vdata — A record-based structure where values are stored in fixed-length fields. Fields are defined, named, and typed individually. All records within a Vdata are identical in structure.

Vgroup — A structure for associating sets of data objects. Vgroups define logical relationships and may contain any HDF objects, including other Vgroups.

External Element — Data stored in a separate file, external to the basic HDF file. External elements allow larger product sizes (e.g., up to 12 scenes) and the ability to read L0Rp data without using the HDF library.

4.1.3 Data Representation

Data are both binary and ASCII. Bit and byte ordering follow the Institute of Electrical and Electronics Engineers (IEEE) conventions. The term byte is synonymous with octet as used by the International Standards Organization (ISO).

4.1.4 Notation

Storage types are referred to using the HDF number type nomenclature:

type#

where type is either char (character), int (integer), or float (floating point), and # is a decimal count of the number of bits used to represent the data type. The type mnemonics *int* and *char* may be preceded by the letter u, indicating an unsigned value. For example, the data type *uint32* refers to an unsigned 32-bit integer value.

Table 4-1 lists the storage types relevant to the L0Rp data.

Data Type	HDF Nomenclature
8-bit character	char8
8-bit unsigned integer	uint8
16-bit signed integer	int16
16-bit unsigned integer	uint16
32-bit signed integer	int32
32-bit floating point number	float32
64-bit floating point number	float64

Table 4-1. L0Rp Storage Types

4.2 Structure Overview

The L0Rp data are packaged and distributed as a collection of external elements with an HDF data directory. External elements are distinguished because they exist as separate files and contain only data. Information about their HDF structure and interrelationships is located in the HDF directory.

The following file types may accompany an L0Rp data set:

- Seven band files containing Earth image data (B1-B7)
- Internal Calibration (CAL) data (TM-R only)
- Mirror Scan Correction Data (MSCD)
- Payload Correction Data (PCD)
- Scan Line Offsets (SLO) data
- Archive Metadata (MTA)
- Distribution Product Metadata (MTP)
- Geolocation Index (GEO)
- HDF Directory Information
- Annotation (ANN) file (TM-A only)
- Ancillary (ANC) data (TM-A only)
- Header (HDR) data (TM-A only)
- Calculated Gains and Biases (CGB) (TM-A only)
- README file (included with LPGS L0R products)

Figure 4-1 conceptualizes the collection of external elements that compose a complete single scene L0Rp data. The seven bands of Earth image data are represented by seven SDS external elements. Bands sharing a common ground resolution are logically associated using the Vgroup data structure. Two Vgroups result: Bands 1-5 and Band 7, and Band 6.

The seven bands of IC data follow an identical structure. Two groups are formed based on a common ground resolution. One external element is used to store the IC data. One file contains Band 1 through Band 7.

The MSCD are stored as a Vdata table and are logically grouped using the Vgroup data structure.

The PCD are stored as a Vdata table and are logically united. The SLOs are stored as one Vdata table. One file contains the offsets for Band 1 through Band 7. The Vdata for each band are logically associated with the corresponding Earth image and IC SDS.

The product also contains two metadata files. Metadata are stored as a Vdata table with one long ASCII-character field or string. The metadata files follow the ODL syntax.

One GEO Vdata accompanies the product. Although the GEO Vdata exist as a separate file, it is logically associated with each image and IC band using the Vgroup data structure.

The last element of the file is the IAS-generated calibration parameters. Calibration parameters are stored in a Vdata table composed of three-row ASCII-character fields or strings using the ODL syntax.

An annotation file is distributed with the TM-A products. The annotation file contains the tic marks required for mapping scene-based u,v coordinates to projection space. This is an ASCII ODL file.

Ancillary data are included with TM-A products. This is an ASCII ODL file.

The header file is included with TM-A data and is a binary file.

The CGB file is included with TM-A products and contains the values for the lamp quality, computed lamp state, computed lamp value, gain, bias, applied gain, and applied bias. These values are associated with the respective lines within the image files. This is a binary file.

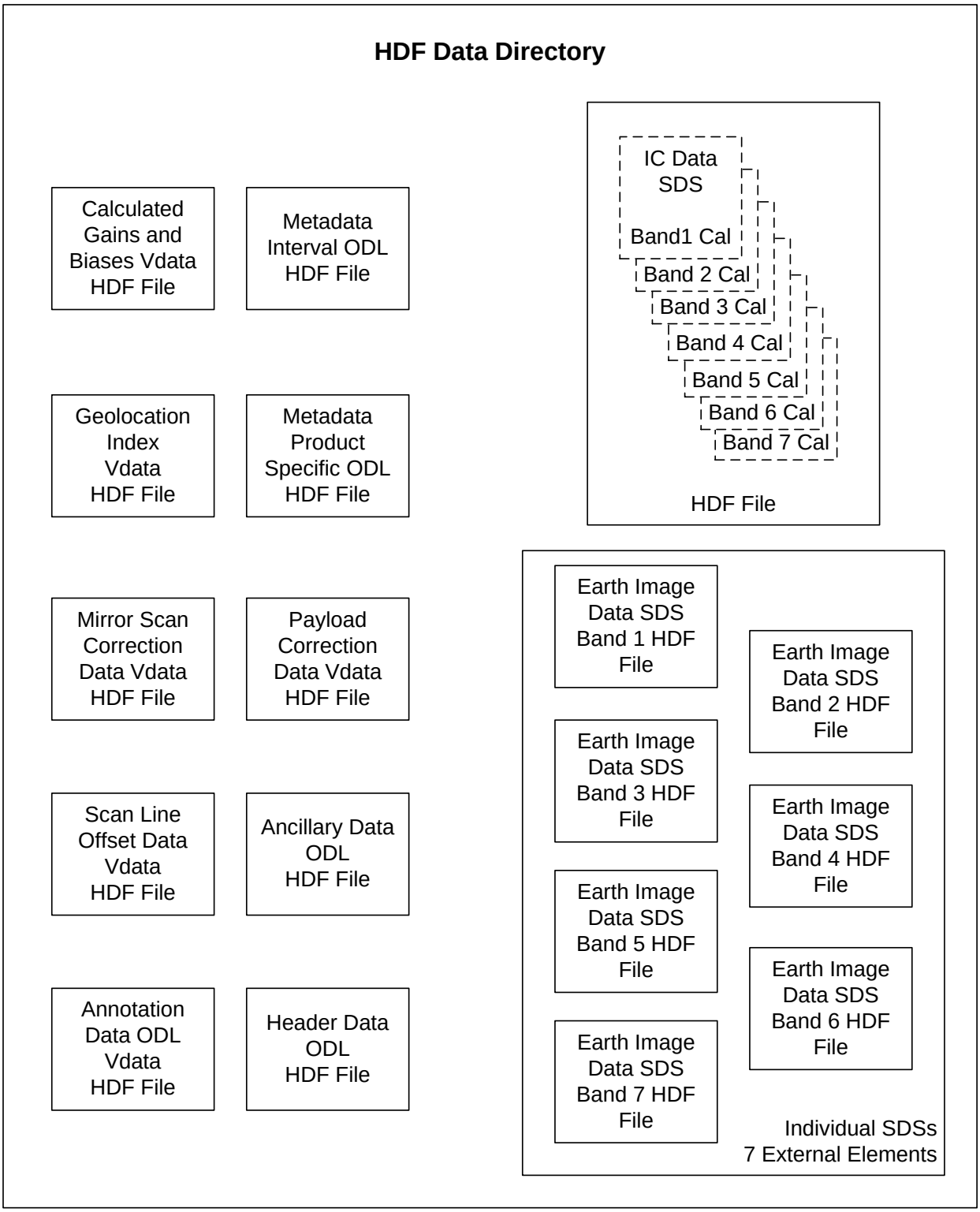

Figure 4-1. A Complete L0Rp Data Set — External Elements

4.3 Detailed Structure

4.3.1 Naming Conventions

All of the HDF data structure names, except the CPF, are derived using the following file-naming notation. These file extensions are not used within the HDF libraries.

LMXsssfnYYDOYHHuuvv_xxx.YYDOYHHMM

Where:

L	Landsat 5 mission
M	TM mission (4 or 5)
X	Landsat X-Band used to downlink data to the Landsat Ground Station (LGS) (1)
sss	Ground Station such as EROS at Sioux Falls (LGS), Alaska Ground Station (AGS), or Spitzbergen Ground Station (SGS). Please see LSDS-547 Landsat Ground Station (GS) Identifiers
f	TM data format (1 = TMR; 0 = TMA)
n	Processor number (0)
YY	Last two digits of the year associated with a contact period (not acquisition time)
DOY	Julian day of year of the contact period
HH	Hour of the contact period within a 24-hour day (00–23)
uu	Subinterval number within this contact period (00–99); the value 00 is used if the interval number is unknown
vv	Data set version number (v = 0 for original or 1–99 for reprocessed data); the value 0 may also represent an unknown version number for non-U.S. processing systems
_ (underscore)	File name partition for readability
xxx	Type of data: MSD – MSCD PCD – PCD GEO – Geolocation index B10 through B70 – Earth image data CAL – IC data CGB – Calculated Gains and Biases SLO – Scan Line Offset data HDF – Hierarchical Data Format MTA – Metadata (archive metadata) MTP – Metadata (product metadata) ANN – Annotation data ANC – Ancillary data HDR – Header data
.YYDOYHHMM	File name extension generated at product creation, making each product unique. Where: YY = Year DOY = Day of year (Julian day of year) HH = Hour MM = Minutes

Table 4-2. HDF Data Structure Names

4.3.2 SDS Definitions

SDSs store Earth image and IC data. SDSs are simple byte arrays containing only image and no ancillary data. A one-to-one relationship exists for each band SDS data

line and corresponding record in the SLO Vdata. SDS scan line time codes, scan numbers, and data line numbers exist in this Vdata and unite the image data with the SLOs, MSCD, and PCD during Level 1 processing.

Note: Scan and data line numbers for SDSs are referenced relative to the interval from which they were extracted. They do not start with '1' unless the product includes the first scan in an interval.

When creating data objects, each object should be made extendible. Doing so allows two similar data objects to be combined.

4.3.2.1 TM Earth Image Data

The TM Earth image data for Band 1 through Band 7 are structured as individual SDSs within separate files or external elements. Table 4-3 lists the Earth image SDSs that compose the L0Rp data.

No.	SDS Name	Description	Number Type	Rank	Dimensions
1	"LMXsss1nYYDOYHHuuvv.B10"	SDS containing 30-meter TM Band 1 Earth image data	uint8	2	Scan line count * 16 by 6600 (row major)
2	"LMXsss1nYYDOYHHuuvv.B20"	SDS containing 30-meter TM Band 2 Earth image data	uint8	2	Scan line count * 16 by 6600 (row major)
3	"LMXsss1nYYDOYHHuuvv.B30"	SDS containing 30-meter TM Band 3 Earth image data	uint8	2	Scan line count * 16 by 6600 (row major)
4	"LMXsss1nYYDOYHHuuvv.B40"	SDS containing 30-meter TM Band 4 Earth image data	uint8	2	Scan line count * 16 by 6600 (row major)
5	"LMXsss1nYYDOYHHuuvv.B50"	SDS containing 30-meter TM Band 5 Earth image data	uint8	2	Scan line count * 16 by 6600 (row major)
6	"LMXsss1nYYDOYHHuuvv.B60"	SDS containing 120-meter TM Band 6L Earth image data	uint8	2	Scan line count * 4 by 1650 (row major)
7	"LMXsss2nYYDOYHHuuvv.B70"	SDS containing 30-meter TM Band 7 Earth imagery	uint8	2	Scan line count * 16 by 6600 (row major)

Table 4-3. L0Rp Earth Image SDSs

4.3.2.2 TM IC Data

The TM IC data are also structured as individual SDSs but not in a single SDS per file arrangement. Rather, one external element is used for Band 1 through Band 7. The IC data are stored in a band sequential format for reflective bands (Band 1-5, Band 7) followed by the thermal band (Band 6) in ascending order.

No.	SDS Name	Description	Number Type	Rank	Dimensions
1	“LMXsss1nYYDOYHHuuv.C10”	SDS containing TM Band 1 calibration data	uint8	2	Scan line count * 16 by 1450 (row major)
2	“LMXsss1nYYDOYHHuuv.C20”	SDS containing TM Band 2 calibration data	uint8	2	Scan line count * 16 by 1450 (row major)
3	“LMXsss1nYYDOYHHuuv.C30”	SDS containing TM Band 3 calibration data	uint8	2	Scan line count * 16 by 1450 (row major)
4	“LMXsss1nYYDOYHHuuv.C40”	SDS containing TM Band 4 calibration data	uint8	2	Scan line count * 16 by 1450 (row major)
5	“LMXsss1nYYDOYHHuuv.C50”	SDS containing TM Band 5 calibration data	uint8	2	Scan line count * 16 by 1450 (row major)
7	“LMXsss2nYYDOYHHuuv.C70”	SDS containing TM Band 7 calibration data	uint8	2	Scan line count * 16 by 1450 (row major)
6	“LMXsss1nYYDOYHHuuv.C60”	SDS containing TM Band 6 calibration data	uint8	2	Scan line count * 4 by 725 (row major)

Table 4-4. L0Rp IC SDSs

4.3.3 Vdata Definitions

Vdata structures are employed to store MSCD, PCD, SLO, metadata, and GEO information for the product. All L0Rp Vdata are designated full interlace, which organizes the Vdata on a record-by-record basis. This mode allows additional records to be appended.

4.3.3.1 MSCD Vdata

The number of MSCD Vdata records is equal to the number of data scans in the product plus one. The additional record is included because several fields reference the previous scan line. The spacecraft time associated with each TM scan is provided in seconds since January 6, 1980, and is a Julian day, time-of-day format. Table 4-5 lists the contents of the MSCD Vdata records.

Vdata Name: “LMXsssfnYYDOYHHuuvv.MSD”					
Vdata Class: LACS_MSCD					
Interlace Type: FULL_INTERLACE					
Bytes Per Logical Record: 55					
Number of Records: One record per product scan line (major frame)					
L0Rp MSCD Field Name	**Number Type**	**Order**	**Description**	**Remarks**	**LACS Field / Comments**
scan_no	int16	1	Interval scan line counter values = 1-11725	Provides a sequence counter for the TM scans (major frames) contained in L0Rp data. This counter is referenced relative to the original interval, not the product ordered.	None
time	float64	1	TM scan time in seconds since 00:00:00 January 6, 1980.		None
scan_timecode	char8	25	Scan line time of the format YYYY:ddd:hh:mm:ss:tttttt where YYYY = Four-digit Julian year ddd = Day (01–366) hh = Hours (00–23) mm = Minutes (00–59) ss = Seconds(00–59) tttttt = Fractional seconds [0–9999375, where the clock cycle is 1/16 millisecond (ms)]	The TM scan start time extracted from the timecode minor frames of the TM major frame data reported in this data record. A computed scan start time is provided if a valid time is not available from the time code minor frames. Time is expressed using the Greenwich Mean Time (GMT) standard.	Start_time_code
Eol_location	uint16	1	Counted active scan line length in minor frames		MSCD_line_length

Vdata Name: “LMXsssfnYYDOYHHuuvv.MSD”					
Vdata Class: LACS_MSCD					
Interlace Type: FULL_INTERLACE					
Bytes Per Logical Record: 55					
Number of Records: One record per product scan line (major frame)					
L0Rp MSCD Field Name	**Number Type**	**Order**	**Description**	**Remarks**	**LACS Field / Comments**
Scan_dir_vote	uint8	1	Scan direction majority vote quality 0 = All bits in all scan direction word groups are equal. 1 = At least 1 bit in the scan direction word groups is not equal to the other bits. 2 = Scan direction is not found for a missing and/or an entirely filled scan and is therefore interpolated from the previous scan if possible or is classified as unknown. 255 – May be used for fill value if not calculated.	A majority vote quality of one may indicate an error with the received and/or decoded scan direction value (back-to-back forward or reverse scans).	LACS does not populate the full interval MSCD with these data. This column is filled with 255 until LACS populates the full interval data.
scan_dir	char8	1	Scan direction character F = Forward scan R = Reverse scan U = Unknown	Scan direction for the previous scan. If the scan direction is Unknown, the default Forward direction is used for placing the data.	Scan_direction
Fhs_vote	uint8	1	First Half Scan (FHS) error majority vote quality 0 = All bits in each FHS error word group are equal. 1 = At least 1 bit in at least one FHS error word group is not equal to other bits in the group. 255 – May be used for fill value if not calculated.	A value of 1 indicates that the received / decoded fhs_err value is probably erroneous.	LACS does not populate the full interval MSCD with these data. This column is filled with 255 until LACS populates the full interval data.
Fhs_err	int16	1	FHS error count: –2048 to 2047 This is a 12-bit number provided in an int16 field using two’s complement notation.	FHS error for the previous scan.	FHSERR_count

Vdata Name: “LMXsssfnYYDOYHHuuvv.MSD”					
Vdata Class: LACS_MSCD					
Interlace Type: FULL_INTERLACE					
Bytes Per Logical Record: 55					
Number of Records: One record per product scan line (major frame)					
L0Rp MSCD Field Name	**Number Type**	**Order**	**Description**	**Remarks**	**LACS Field / Comments**
Shs_vote	uint8	1	Second Half Scan (SHS) error majority vote quality 0 = All bits in each SHS error word group are equal. 1 = At least one bit in at least one SHS error word group is not equal to other bits in the group. 255 – May be used for fill value if not calculated.	A value of 1 indicates that the received / decoded shs_err value is probably in error.	LACS does not populate the full interval MSCD with these data. This column is filled with 255 until LACS populates the full interval data.
Shs_err	int16	1	SHS error count: -2048 to 2047 This is a 12-bit number provided in an int16 field using two’s complement notation.	SHS error for the previous scan.	SHSERR_count
scan_sync	uint8	1	0=OK, 1=major frame lock loss	Lock loss indicator	MSCD _lock_loss
minf_faults	int16	1	Number of minor frames with sync pattern errors.		MSCD_bad_syncs
filled_scan_flag	uint8	1	0=OK, 1=Fill, 2=bad time code	This flag indicates whether any predetermined fill data were used to build this TM scan (major frame).	MSCD_fill_flag
minf_received	int16	1	Number of minor frames in the entire scan.	This is computed counting the scan-line-start (major from synchronization pattern) and including the last partial minor frame when present and only when it contains at least 6 bytes; that is, when it includes the PCD byte.	Number_minor_frames

Vdata Name: “LMXsssfnYYDOYHHuuvv.MSD”					
Vdata Class: LACS_MSCD					
Interlace Type: FULL_INTERLACE					
Bytes Per Logical Record: 55					
Number of Records: One record per product scan line (major frame)					
L0Rp MSCD Field Name	**Number Type**	**Order**	**Description**	**Remarks**	**LACS Field / Comments**
Bit_slip_cadus	int16	1	Number of minor frames with bit slip errors in this major frame.		MSCD_bit_slips
minf_flywheels	int16	1	Number for flywheel minor frames		MSCD_flywheel
FHSTimeErr	float32	1	FHS time errors (usec)	TM-A Only	
SHSTimeErr	float32	1	SHS time errors	TM-A Only	
ScanTimeCodeQuality	Uint8	1	Time code quality 0 = good 1 = substituted	TM-A Only	
ScanLineQuality		1	Scan line quality 0 = good image data 1 = substituted on input (pass 1) 2 = substituted on output (pass 2) 3 = substituted on both input and output 4 = substituted due to bad detector	TM-A Only	

Table 4-5. MSCD Vdata

4.3.3.2 PCD Vdata

A PCD major frame is generated every 4.096 spacecraft seconds. Each record in the PCD Vdata represents a major frame and is uniquely identified by its associated spacecraft time, which is extracted or computed from raw PCD.

Table 4-6 lists the contents of the PCD Vdata. All data in the table are presented in their respective engineering units except for the TM thermistor temperatures. Coefficients found in the CPF are required for this conversion.

Vdata Name: “LMXsssfnYYDOYHHuuvv.PCD”					
Vdata Class: LACS_PCD					
Interlace Type: FULL_INTERLACE					
Bytes Per Logical Record: = 26,433					
Field Name	**Number Type**	**Count**	**Description / Comments**	**Remarks**	**LACS-R Location**
cycle_count	uint8	1	PCD cycle number (00-99). Approximately 52 PCD cycles are in a 14-minute interval. Starts at 1.	The PCD cycle number associated with the PCD major frame reported in this record of the PCD file. A PCD cycle consists of a set of four consecutive PCD major frames: (0), (1), (2), and (3). This number is incremented by one for each PCD major frame.	Calculated while reading the PCD
majf_count	uint8	1	Major frame counter (001-255) The maximum number of PCD major frames in a 14-minute interval is 206.	The major frame counter value of the PCD major frame reported in this record of the interval PCD file. The PCD major frame number is incremented by one for each new PCD major frame added to this file.	Calculated while reading the PCD
majf_id	uint8	1	PCD major frame ID (0-3) Fill value = 255	PCD major frame (0) is identified by the presence of spacecraft ID and timecode information. Other PCD major frames are identified by their ID numbers (1-3).	LtoGSIDv9 page 51, minor frame 96 word 72
majf_time	float64	1	PCD major frame time in GMT integer and fractional seconds since 00:00:00 January 6, 1980, rounded to seven decimal places. Fill value = 10		LtoGSIDv9 pages 51,52, major frame 0 minor frames 96-103 word 72 (major frames 1-3 are calculated from major frame 0)

Vdata Name: “LMXsssfnYYDOYHHuuvv.PCD”					
Vdata Class: LACS_PCD					
Interlace Type: FULL_INTERLACE					
Bytes Per Logical Record: = 26,433					
Field Name	**Number Type**	**Count**	**Description / Comments**	**Remarks**	**LACS-R Location**
scan_timecode	char8	25	Scan line time of the form YYYY:ddd:hh:mm:ss.ttttttt where YYYY = Four-digit Julian year ddd = Julian day (001-366) hh = Hours (00-23) ss = Seconds (00-59) ttttttt = Fractional seconds (0-9999375, where the clock cycle is 1/16 ms) Fill value = $$$$	For PCD major frame (0), the spacecraft time is extracted from PCD major frame (0) of a PCD cycle. For PCD major frames (1-3), the spacecraft timecode is interpolated using the time received for PCD major frame (0) of the associated or following PCD cycle. Time is expressed using the GMT standard. Fill value occurs at the beginning of the PCD file when there has not yet been a valid major frame (0) or there is a missing cycle.	The majf_time converted to an ASCII representation.
bands_state	char8	7	Indicates TM bands on / off states for data. = 1234567 for all bands "ON" state data. A "-" indicates an off state or a missing band (e.g., "123-567" means Band 4 is off or missing). Fill value = $$$$$$$	This information is extracted from major frame 2 minor frame 32, word 72, bits 0-6. A spare is located in major frame 0 minor frame 35, word 72, bits 0-6.	LtoGSIDv9 page 53, major frame 2 minor frame 32 word 72. Also known as "Serial Word B."
vote_errors	uint16	1	= 0-16384 packed words in a PCD major frame. 65535 - May be used for fill value if not calculated.	Count of (packed) PCD major frame words found to contain voting errors during the packing of a PCD word / minor frame. Some PCD major frame words may contain erroneous or filled data.	Calculated while reading the PCD

Vdata Name: “LMXsssfnYYDOYHHuuvv.PCD”					
Vdata Class: LACS_PCD					
Interlace Type: FULL_INTERLACE					
Bytes Per Logical Record: = 26,433					
Field Name	**Number Type**	**Count**	**Description / Comments**	**Remarks**	**LACS-R Location**
minf_sync_errors	uint8	1	= 0-128 minor frames in a major frame.	Count of PCD minor frames received with sync errors in this major frame. Some PCD words may be lost and filled due to minor frame sync errors.	Calculated while reading the PCD
minf_id_errors	uint8	1	= 0-128 minor frames in a major frame. 255 may be used for fill value if not calculated.	Count of PCD minor frames received with incorrect minor frame IDs (counter values). Corrected IDs are filled in.	Calculated while reading the PCD
majf_flag	uint8	1	PCD major frame flag where 0 = Valid major frame ID, may be used for fill value if classified as unknown. 1 = Incorrect major frame ID 2 = Missing major frame ID; used for major frames (1), (2), and (3) only. 3 = Non-applicable; A value of 3 is only used for major frame; (0). If in error, the PCD major frame ID is corrected by LACS. 255 may be used for fill value if not calculated.	The major frame ID is part of the PCD major frame for types 1, 2, and 3. It is repeated in the slots used for the time code in type 0 major frames. Because it is repeated, errors can be detected by comparing the repeated values. This flag could help diagnose problems with major frame sequencing. It also identifies major frame IDs that have been generated for filled or partially filled major frames. Indicates the quality of the PCD major frame ID found in word 72, minor frames 96-103 of PCD major frames (1), (2), and (3). PCD major frame (0) contains the timecode flag (see below).	

Vdata Name: “LMXsssfnYYDOYHHuuvv.PCD”					
Vdata Class: LACS_PCD					
Interlace Type: FULL_INTERLACE					
Bytes Per Logical Record: = 26,433					
Field Name	**Number Type**	**Count**	**Description / Comments**	**Remarks**	**LACS-R Location**
timecode_flag	uint8	1	Valid PCD timecode flag, where 0 = Valid timecode and spacecraft ID, may be used for fill value if classified as unknown. 1 = Computed timecode 2 = Corrected spacecraft ID 3 = Flags 1 and 2 combined 4 = Fill value for timecode 5 = Fill value for timecode and spacecraft ID 255 - May be used for fill value if not calculated.	Indicates the quality of the spacecraft ID and timecode data contained in word 72, minor frames 96-103, of PCD major frames (0). For PCD major frames (1) (3), the timecode flag is also interpolated / derived from the timecode flag used for major frame (0).	
spacecraft_id	char8	1	"5" for Landsat 5, "4" for Landsat 4, and 0 for Unable to read spacecraft ID.	The Landsat 4/5 spacecraft ID is determined from bits 0-3 of PCD timecode word 96 located in major frame (0) of each PCD cycle. For the remaining three major frames in a PCD cycle, this spacecraft ID is copied for each major frame. The spacecraft ID is also forced to "5" when an erroneous ID is read or the spacecraft ID is missing. The spacecraft ID error is noted in the s/c_id_pcd field.	LtoGSIDv9 pages 51,52, major frame 0 minor frame 96 word 72 bits 0-3 Landsat 5 = 1101(13) Landsat 4 = 1110(14)
TM Telemetry Sampled @4.096 Seconds Rate The following TM telemetry is sampled every 4.096 seconds and inserted into the next PCD major frame. Major frames with missing or erroneous values are filled with ones (FF in hexadecimal for uint8 and FFFF for uint16).					

Vdata Name: “LMXsssfnYYDOYHHuuvv.PCD”					
Vdata Class: LACS_PCD					
Interlace Type: FULL_INTERLACE					
Bytes Per Logical Record: = 26,433					
Field Name	**Number Type**	**Count**	**Description / Comments**	**Remarks**	**LACS-R Location**
black_body_ temp_iso	uint8	1	Blackbody temperature	Blackbody temperature from LtoGSIDv9 page 53. Word 72 of minor frame number 16.	LtoGSIDv9 pages 53-54, major frame 2 minor frames 16,35 word 72
cal_shutr_flag _ temp	uint8	1	Calibration shutter flag temperature in Celsius		LtoGSIDv9 pages 53-54, major frame 2 minor frames 18 word 72
baffle_temp_ heater	uint8	1	Baffle temperature (heater)		LtoGSIDv9 page 53, major frame 2 minor frame 20 word 72
pdf_ad_groun d_ ref	uint16	1	PDF Analog / Digital (A/D) ground reference	Only the 12 ground reference bits G0-G11 are included and not the constant first four bits found in minor frame 116 of word 72.	LtoGSIDv9 page 43,44,56, major frames 0-3 minor frames 116-117 word 72
TM Telemetry Sampled @16.384 Seconds Rate The following PCD values are repeated for each PCD major frame. Major frames with missing or erroneous values are filled with ones (FF in hexadecimal). The following PCD values should be copied in the same format as found in their respective PCD words / minor frames in a PCD major frame.					
serial_word_b	uint8	1	Bit0=Band 1 ON/OFF; Bit1=Band 2 ON/OFF; Bit2=Band 3 ON/OFF; Bit 3=Band 4 ON/OFF; Bit4=Band 5 ON/OFF; Bit5=Band 6 ON/OFF; Bit6=Band 7 ON/OFF; Bit7=Cold Stage Telemetry ON/OFF		LtoGSIDv9 page 53, major frame 2 minor frame 32 word 72

Vdata Name: “LMXsssfnYYDOYHHuuvv.PCD”					
Vdata Class: LACS_PCD					
Interlace Type: FULL_INTERLACE					
Bytes Per Logical Record: = 26,433					
Field Name	**Number Type**	**Count**	**Description / Comments**	**Remarks**	**LACS-R Location**
serial_word_d	uint8	1	Bit0=C Lamp 1 ON/OFF; Bit1=C Lamp 2 ON/OFF; Bit2=C Lamp 3 ON/OFF; Bit3=C Lamp 1 Override ON/OFF; Bit4=C Lamp 2 Override ON/OFF; Bit5=C Lamp 3 Override ON/OFF 5; Bit6=Cal Sequencer ON/OFF 6; Bit7=Multiplexer Backup ON/OFF 7		LtoGSIDv9 page 53, major frame 2 minor frame 34 word 72
serial_word_e	uint8	1	Bit0=Spare 0; Bit1=Spare; Bit2=Blackbody ON/OFF; Bit3=Blackbody T2 ON/OFF; Bit4=Blackbody T3 ON/OFF; Bit5=Blackbody Backup ON/OFF; Bit6=SME 1 ON/OFF; Bit7=SME 2 ON/OFF		LtoGSIDv9 pages 53-54, major frame 2 minor frame 35 word 72
serial_word_f	uint8	1	Bit0=Spare, Bit1=Spare; Bit2=Spare; Bit3=Spare; Bit4=Spare; Bit5=Spare; Bit6=Multiplexer ON/OFF; Bit7=Primary Midscan Pulse ON/OFF		LtoGSIDv9 page 54, major frame 2 minor frame 36 word 72

Vdata Name: “LMXsssfnYYDOYHHuuvv.PCD”					
Vdata Class: LACS_PCD					
Interlace Type: FULL_INTERLACE					
Bytes Per Logical Record: = 26,433					
Field Name	**Number Type**	**Count**	**Description / Comments**	**Remarks**	**LACS-R Location**
serial_word_g	uint8	1	Bit0=Scan Line Corrector 1 ON/OFF; Bit1=Scan Line Corrector 2 ON/OFF; Bit2=Calibration Shutter ON/OFF; Bit3=Calibration Shutter Phase Lock; Bit4=Calibration Shutter Amp. Lock; Bit5=Backup Shutter ON/OFF; Bit6=Backup Shutter Phase Lock; Bit7=Backup Shutter Amp. Lock		LtoGSIDv9 page 54, major frame 2 minor frame 37 word 72
serial_word_l	uint8	1	Bit0=DC Restore Normal/Not Normal 0; Bit1=Frame DC Restore Selected Y/N; Bit2=Telemetry Scaling ON/OFF; Bit3=Spare; Bit4=Spare; Bit5=Midscan Pulse Backup ON/OFF; Bit6=SME 1 Select SAM; Bit7=Spare		LtoGSIDv9 page 54, major frame 2 minor frame 39 word 72
silicon_focal_ plane_assemb ly_temp	uint8	1	Silicon focal-plane assembly in Celsius	LtoGSIDv9 page 53 word 72 of minor frame number 17	
cfpa_monitor_ temp	uint8	1	Cold Focal Plane Assembly (CFPA) monitor temperature		LtoGSIDv9 page 53, major frame 2 minor frame 21 word 72
slc_temp	uint8	1	Scan Line Corrector Temperature in Celsius		LtoGSIDv9 page 53, major frame 2 minor frame 24 word 72
cal_shutr_hub _ temp	uint8	1	Calibration shutter hub temperature in Celsius		LtoGSIDv9 page 53, major frame 2 minor frame 25 word 72

Vdata Name: “LMXsssfnYYDOYHHuuvv.PCD”					
Vdata Class: LACS_PCD					
Interlace Type: FULL_INTERLACE					
Bytes Per Logical Record: = 26,433					
Field Name	**Number Type**	**Count**	**Description / Comments**	**Remarks**	**LACS-R Location**
relay_optics_ temp	uint8	1	Relay Optics Temperature in Celsius		LtoGSIDv9 page 53, major frame 2 minor frame 28 word 72
primary_mirror _ temp	unit8	1	Primary Mirror Temperature in Celsius		LtoGSIDv9 page 53, major frame 2 minor frame 40 word 72
secondary_mir ror_temp	unit8	1	Primary Mirror Temperature in Celsius		LtoGSIDv9 page 53, major frame 2 minor frame 42 word 72
Ephemeris Data The ephemeris data, consisting of the position and velocity components, are available on a PCD major frame basis.					
ephem_positio n_xyz	float64	3	x,y,z position range: +/ 8.3886 x 106 meters. Fill value = 10e7	The coordinate system is in Earth-Centered Inertial True-Of-Date (ECITOD).	LtoGSIDv9 pages 49-51, major frames 1&3 minor frames 16-27 word 72
ephem_velocit y_xyz	float64	3	x,y,z velocity range: +/ 8.0 meters/ms Fill value = 10		LtoGSIDv9 pages 49-51, major frames 1&3 minor frames 28-39 word 72
Attitude Estimate The spacecraft calculates an estimate of the attitude represented as Euler parameters. Components 1-3 define the eigen-axis of rotation in Earth Center Inertial (ECI) coordinates, and component 4 defines the rotation about that axis.					
attitude_est_e pa1234	float64	4	epa1, epa2, epa3, epa4 Fill value = 2	epa1, epa2, epa3 are components 1-3. epa4 is component 4.	LtoGSIDv9 pages 47-49, minor frames 0-15 word 72
Gyro (Inertial Measurement Unit (IMU) Axes) Data Note: The following IMU axes (x, y, z) readings are repeated 64 times in each major frame. The IMU axes values are in arc-seconds of angular motion. A total of 256 readings (samples) are collected for each PCD cycle. The Gyro data order is as follows: all 64 roll values (Roll-1, Roll-2...), all 64 pitch values (Pitch-1, Pitch-2...), all 64 yaw values (Yaw-1, Yaw-2...). Each IMU axes counter value is first constructed by concatenating the 3 bytes for each axis (e.g., x1, x2, x3) and then converting to arc-seconds. When converting the IMU counter values to engineering units, each increment or decrement in the 24-bit counter value of an IMU axis represents a 0.05 arc-second change. The data are in the IMU reference frame. To convert to the spacecraft reference frame, use the Gyro to Attitude Matrix in the CPF. IMU X corresponds to spacecraft roll. IMU Y corresponds to spacecraft yaw. IMU Z corresponds to spacecraft negative pitch. Fill values are MAXFLOAT.					

Vdata Name: “LMXsssfnYYDOYHHuuvv.PCD”					
Vdata Class: LACS_PCD					
Interlace Type: FULL_INTERLACE					
Bytes Per Logical Record: = 26,433					
Field Name	**Number Type**	**Count**	**Description / Comments**	**Remarks**	**LACS-R Location**
gyro-select_x	char8	1	= "P" (primary) for gyro Inertial Reference Unit (IRU) channel 1 selected, or = "S" (secondary) for gyro IRU channel 2 selected. Fill value = "F"	Minor frame 29 in subcom word 72 of PCD major frame 0 identifies the gyro channel selected for the X-axis. Gyro 1=(00)16, Gyro 2=(01)16 as described in Section 5.4.7.2 (l) of the Landsat to Ground Station Interface Description Document revision 9, January 1986.	LtoGSIDv9 page 58 Table 9b, major frame 0 minor frame 29 word 72
gyro-select_y	char8	1	= "P" (primary) for gyro IRU channel 1 selected, or = "S" (secondary) for gyro IRU channel 2 selected. Fill value = "F"	Minor frame 30 in subcom word 72 of PCD major frame 0 identifies the gyro channel selected for the Y-axis. Gyro 1=(00)16, Gyro 2=(01)16 as described in Section 5.4.7.2 (l) of the Landsat to Ground Station Interface Description Document version 9, January 1986.	LtoGSIDv9 page 58 Table 9b, major frame 0 minor frame 30 word 72
gyro-select_z	char8	1	= "P" (primary) for gyro IRU channel 1 selected, or = "S" (secondary) for gyro IRU channel 2 selected. Fill value = "F"	Minor frame 31 in subcom word 72 of PCD major frame 0 identifies the gyro channel selected for the Z-axis. Gyro 1=(00)16, Gyro 2=(01)16 as described in Section 5.4.7.2 (l) of the Landsat to Ground Station Interface Description Document version 9, January 1986.	LtoGSIDv9 page 58 Table 9b, major frame 0 minor frame 31 word 72

Vdata Name: “LMXsssfnYYDOYHHuuvv.PCD”					
Vdata Class: LACS_PCD					
Interlace Type: FULL_INTERLACE					
Bytes Per Logical Record: = 26,433					
Field Name	**Number Type**	**Count**	**Description / Comments**	**Remarks**	**LACS-R Location**
imu_x_roll_x00_x63	float64	64	= -419430.4 to + 419430.4 arc-seconds for components x00-x63 in the PCD major frame	An integer value in the range -2^23 to 2^23 multiplied by 0.05. Also see above group comment.	LtoGSIDv9 pages 45-46, major frames 0-3 minor frames 0-126(Even) words 81,97 AND major frames 0-3 minor frames 1-127(Odd) word 17
imu_y_pitch_y00_y63	float64	64	= -419430.4 to + 419430.4 arc-seconds for components y00-y63 in the PCD major frame	An integer value in the range -2^23 to 2^23 multiplied by 0.05. Also see above group comment.	LtoGSIDv9 pages 45-46, major frames 0-3 minor frames 0-126(Even) word 113 AND major frames 0-3 minor frames 1-127(Odd) words 33,49
imu_z_yaw_z00_z63	float64	64	= -419430.4 to + 419430.4 arc-seconds for components z00-z63 in the PCD major frame	An integer value in the range -2^23 to 2^23 multiplied by 0.05. Also see above group comment.	LtoGSIDv9 pages 45-46, major frames 0-3 minor frames 1-127(Odd) words 81,97,113
Gyro Drift Data The gyro drift data are reported once per PCD cycle in major frame (0) only. The calculation is made at the PCD cycle time code minus 14.337 seconds in the ACS reference axis coordinate system.					
gyro_drift_theta_xyz	float64	3	x, y, z gyro drift. The units of gyro drift (rate) data for each axis are in radians/512ms. Fill value = -1.0		LtoGSIDv9 pages 46-47, major frame 0 minor frames 16-27 word 72
ADS Data Note: The minor frame IDs are reported serially for each major frame. The 16 sets of ADS x, y, z values are reported as a distinct entry for each of the 128 minor frames in a PCD major frame. All ADS x, y, z measurements are converted to microradians and reported in ascending order of their source words and minor frames in a PCD major frame. All data are reported with single floating point precision. A total of 16 ADS measurements, each consisting of the x, y, and z components, are received in a PCD minor frame. Fill value for all, including mnfm_ids_000_127, is 255.					
mnfm_ids_000_127	uint8	128	Minor frame counter or ID: 000-127	The PCD minor frame counter value / ID from word location 65 of each minor frame. There are 128 (IDs: 000-127) minor frames in a PCD major frame.	LtoGSIDv9 page 51, minor frames 0-127 word 65

Vdata Name: “LMXsssfnYYDOYHHuuvv.PCD”					
Vdata Class: LACS_PCD					
Interlace Type: FULL_INTERLACE					
Bytes Per Logical Record: = 26,433					
Field Name	**Number Type**	**Count**	**Description / Comments**	**Remarks**	**LACS-R Location**
ads_xyz16_mnfm	float32	6144	ADS measurement x01, y01, z01 through x16,y16,z16 received in minor frame 0 - 127. (float32 * 48 * 128)	Digital count 0 is the maximum positive angular displacement and count 4095 is the maximum negative angular displacement. The Least Significant Bit (LSB) of each count is 250/2^11 microradians.	LtoGSIDv9 pages 39,42
ads_temps	float32	4	ADSA temperature values stored in Celsius. First float32 stores x, second stores y, third stores z, and fourth lists the a/d_elec. 255 = fill		LtoGSIDv9 pages 43,45, minor frames 108-115 word 72
ephem_data_quality	char8	1	Ephemeris Data Point Quality: ephem_data_quality = "g" for good data and "m" for missing data	L0Rp subsetter determines and produces for each PCD major frame.	

Table 4-6. PCD Vdata

4.3.3.3 SLO Vdata

The SLO tables provide the amount of zero-fill before actual scene and calibration data and after actual scene data on a data-line-by-data-line basis. Offsets result from the detector arrangement on the two focal planes, a scan line length that can vary from nominal, and the decision to include all data in the L0Rp data set. One SLO Vdata exists per product band or band segment. The number of Vdata records or entries is equal to the number of data lines in the corresponding band or band segment file.

One element or file stores the SLO Vdata. The element or file is ordered or stacked in a band sequential format, which means all Band 1 records are followed by Band 2 records, followed by Band 3 records, and so on.

As with other product tables, the SLO Vdata follow similar naming conventions. However, the extensions vary to associate each Vdata with its particular band. Table 4-7 lists the SLO names.

Band 1 – “LMXsssfnYYDOYHHuuvv.O10”
Band 2 – “LMXsssfnYYDOYHHuuvv.O20”
Band 3 – “LMXsssfnYYDOYHHuuvv.O30”
Band 4 – “LMXsssfnYYDOYHHuuvv.O40”
Band 5 – “LMXsssfnYYDOYHHuuvv.O50”
Band 6 – “LMXsssfnYYDOYHHuuvv.O60”
Band 7 – “LMXsssfnYYDOYHHuuvv.O70”

Table 4-7. SLO Vdata Naming Convention

Table 4-8 lists the contents of the SLOs.

Vdata Name: “LMXsssfnYYDOYHHuuvv.ONN”				
Vdata Class:				
Interlace Type: FULL_INTERLACE				
Bytes Per Logical Record: 46				
Number of Records: One record per data line for the corresponding band file.				
Field Name	**Number Type**	**Count**	**Description**	**Remarks**
scan_timecode	char8	25	Scan line time of the form ‘YYYY:ddd:hh:mm:ss.tttttt’ where YYYY = Four-digit Julian year ddd = Day (01 through 366) hh = Hours (00 through 23) mm = Minutes (00 through 59) ss = Seconds (00 through 59) tttttt = Fractional seconds (0–9999375, where the clock cycle is 1/16 ms)	The TM scan start time extracted from the timecode minor frames of the TM major frame data reported in this record. A computed scan start time is provided if a valid time is not available from the TM time code minor frames. The scan time code is referenced to GMT.
scan_time	float64	1	The TM scan time in decimal notation seconds since midnight on January 1, 1993, rounded to seven decimal places.	The scan_time is obtained by converting the scan_timecode (last entry) to seconds. This is also referenced to GMT.
scan_no	uint16	1	scan_no = 1–11,725 The maximum scan count is based on an interval duration of 14 minutes for 35 scenes, each consisting of 335 non-overlapping scans.	A sequence counter for TM scans (major frames) contained in an interval. The TM scan counter is incremented by one for each new scan, real, or flywheeled, added to the interval file. This counter is referenced relative to the original interval, not the product ordered.

Vdata Name: “LMXsssfnYYDOYHHuuvv.ONN”				
Vdata Class:				
Interlace Type: FULL_INTERLACE				
Bytes Per Logical Record: 46				
Number of Records: One record per data line for the corresponding band file.				
Field Name	**Number Type**	**Count**	**Description**	**Remarks**
scan_data_line_no	uint32	1	scan_data_line_no = SSSSSS where SSSSSS = 1–187,600 for Bands 1–5 and Band 7 = 1–46,900 for Band 6	The scan line counter is incremented for each detector data line added to the product band file. There are 16 scan data lines each for Bands 1–5 and Band 7 and 4 scan data lines for Band 6 in each TM scan. The maximum line counts are shown for a 14-minute interval (35 scenes).
detector_id	uint8	1	Where the detector_id is in the range: = 1–16 for Bands 1–5 and Band 7 = 1–4 detectors for Band 6	Each scan line in an image file consists of samples from a single detector of a single band. Each detector, chosen in a descending ID order, is used once during each scan to generate a scan line.
scan_data_line_offset_rhs	int16	1	= 0– 287 bytes for Bands 1–5 and Band 7 = 0– 140 bytes for Bands 6 The scan line data may be shifted to the right in the band data buffer after an integer-pixel alignment.	The scan line data are shifted to the right in a larger buffer to accommodate integer pixel alignment without data loss. After integer-pixel alignment, this field indicates the trailing zero-fill buffer for each data line.
scan_data_line_offset_lhs	int16	1	= 0– 287 bytes for Bands 1–5 and Band 7 = 0–140 for Band 6	The Left Hand Side (LHS) offset is not as significant as the Right Hand Side (RHS) margin, which can accommodate scan line length growths due to TM scanner bumper wear. This value is valid for both Earth image and IC data.
scan_data_line offset_rhs_ic	int16	1	= 0–300 bytes for Bands 1–5 and Band 7 = 0–150 for Band 6	This value uniquely identifies the right hand offset for the IC data, which can differ from the Earth image left hand offset due to bumper wear.

Vdata Name: “LMXsssfnYYDOYHHuuvv.ONN”				
Vdata Class:				
Interlace Type: FULL_INTERLACE				
Bytes Per Logical Record: 46				
Number of Records: One record per data line for the corresponding band file.				
Field Name	**Number Type**	**Count**	**Description**	**Remarks**
scan_data_line offset_lhs_ic	Int16	1	= 0–100 bytes for Bands 1–5 and Band 7 = 0–50 for Band 6	This value uniquely identifies the left hand offset for the IC data, which can differ from the Earth image right hand offset due to bumper wear.

Table 4-8. SLO VData

4.3.3.4 GEO Vdata

Table 4-9 lists the contents of the GEO Vdata. The data line numbers are referenced relative to the interval from which the product came and represents the actual overlapping WRS scene corners. The line numbers are 1-based (i.e., the first line in the interval is line 1). A value of zero indicates that there are no data for that resolution or format present in the product.

Vdata Name: "LMXsssfnYYDOYHHuuvv.GEO"			
Vdata Class: Index			
Interlace Type: FULL_INTERLACE			
Bytes Per Logical Record: 73			
Number of Records: One record per WRS scene in the product			
Field Name	**Number Type**	**Count**	**Description**
UlLon	float32	1	Scene longitude - upper left corner = -180.0000 through 180.0000 degrees (with a four-digit precision). A positive value indicates east longitude. A negative (-) value indicates west longitude.
UlLat	float32	1	Scene latitude - upper left corner = -90.0000 through 90.0000 degrees (with a four-digit precision). A positive value indicates north latitude. A negative (-) value indicates south latitude.
UrLon	float32	1	Scene longitude - upper right corner = -180.0000 through 180.0000 degrees (with a four-digit precision). A positive value indicates east longitude. A negative (-) value indicates west longitude.
UrLat	float32	1	Scene latitude - upper right corner = -90.0000 through 90.0000 degrees (with a four-digit precision). A positive value indicates north latitude. A negative (-) value indicates south latitude.

Vdata Name: "LMXsssfnYYDOYHHuuvv.GEO"			
Vdata Class: Index			
Interlace Type: FULL_INTERLACE			
Bytes Per Logical Record: 73			
Number of Records: One record per WRS scene in the product			
Field Name	**Number Type**	**Count**	**Description**
LlLon	float32	1	Scene longitude - lower left corner = -180.0000 through 180.0000 degrees (with a four-digit precision). A positive value indicates east longitude. A negative (-) value indicates west longitude.
LlLat	float32	1	Scene latitude - lower left corner = -90.0000 through 90.0000 degrees (with a four-digit precision). A positive value indicates north latitude. A negative (-) value indicates south latitude.
LrLon	float32	1	Scene longitude - lower right corner = -180.0000 through 180.0000 degrees (with a four-digit precision). A positive value indicates east longitude. A negative (-) value indicates west longitude.
LrLat	float32	1	Scene latitude - lower right corner = -90.0000 through 90.0000 degrees (with a four-digit precision). A positive value indicates north latitude. A negative (-) value indicates south latitude.
FirstLine_30m	int32	1	Beginning scene scan line number - 30m. Format 1 = 1 - 184, 601. A zero indicates no data for this format.
LastLine_30m	int32	1	Ending scene scan line number - 30m. Format 1 = 3000 - 187,600. A zero indicates no data for this format.
FirstLine_120m	int32	1	Beginning scene scan line number - 120m. Format 1 = 1 – 46,151. A zero indicates no data for this format.
LastLIne_120m	int32	1	Ending scene scan line number - 120m. Format 1 = 750 – 46,900. A zero indicates no data for this format.
FullScene	char8	1	Full scene indicator flag (Y or N).

Table 4-9. Geo VData

4.3.4 Header File (TM-A format)

The header file contains general information associated with the satellite and scene (e.g., gain settings, sun angles, multi-point attitude, and ephemeris samplings).

The content of the header file is broken down in the following tables. Table 4-10**,** Table 4-11**,** Table 4-12**,** and Table 4-13 contain data categories that are referenced in Table 4-14. These references provide all parameters contained in the header file for that primary record.

Field Name	Number Type	Count	Description
var	float32	1	var = variance
max	float32	1	max = maximum
min	float32	1	min = minimum
range	float32	1	range = total range

Table 4-10. 'xxx_ATT_STATS_TYPE' Data Category

Field Name	Number Type	Count	Description
nominal	float32	1	nominal = nominal value
max_error	float32	1	max_error = maximum observed error
min_error	float32	1	min_error = minimum observed error
mean_error	float32	1	mean_error = average of observed errors
stdev_error	float32	1	stdev_error = standard deviation of observed errors

Table 4-11. 'xxx_MSCD_STATS_TYPE' Data Category

Field Name	Number Type	Count	Description
seq_num	uint32	1	seq_num = record sequence number
obs_time	float64	8	obs_time = observation times relative to PCD telemetry interval spacecraft start time
pos	float64	8	pos = position (xyz) in km
vel	float64	8	vel = velocity (xyz) in km/sec

Table 4-12. 'xxx_HDR_EPHEM_TYPE' Data Category

Field Name	Number Type	Count	Description
seg_id	uint32	1	Segment ID
cond_code	int32	7x16	Condition code ([band][det])
usable_cal	uint32	8x7x16	Number of usable cal values ([lamp state][band][det])
usable_shutter	uint32	7x16	Number of usable shutter values ([band][det])
corr_coef	float64	7x16	Correlation coefficients ([band][det])
gain	float64	7x16	Gain ratios ([band][det])
hist_mult	float64	7x16	Histogram multiplicative gain mod ([band][det])
hist_add	float64	7x16	Histogram additive bias mod ([band][det])

Table 4-13. 'xxx_HDR_RADCORR_TYPE' Data Category

Vdata Name: “LMXsssfnYYDOYHHuuvv.HDR”			
Vdata Class:			
Bytes Per Logical Record: 55			
Number of Records: One record per product scan line (major frame)			
Field Name	**Number Type**	**Count**	**Description**
data_source	char	1	Data source 'W' = TDRSS / White Sands 'T' = TGS
orbit_num	uint32	1	Orbit number
orbit_dir	char	1	Orbit direction 'A' = Ascending 'D' = Descending
num_pcd_mjf	uint32	1	Number of TM housekeeping records (PCD major frames)
ephem_src	char	1	Ephemeris source 'G' = GPS 'U' = Uplinked
num_raw_ephem	uint32	1	Number of raw ephemeris points
num_raw_ephem_rej	uint32	1	Number of rejected raw ephemeris points
radial_pos	float32	1	Radial position (meters)
along_track_pos	float32	1	Along-track position (meters)
across_track_pos	float32	1	Across-track position (meters)
num_proc_ephem	uint32	1	Number of processed ephemeris points
num_att_lf	uint32	1	Number of low frequency attitude points
num_att_lf_rej	uint32	1	Number of rejected low frequency attitude points
num_att_hf	uint32	1	Number of high frequency attitude points

Vdata Name: “LMXsssfnYYDOYHHuuvv.HDR”			
Vdata Class:			
Bytes Per Logical Record: 55			
Number of Records: One record per product scan line (major frame)			
Field Name	**Number Type**	**Count**	**Description**
num_att_hf_rej	uint32	1	Number of rejected high frequency attitude points
roll_axis_lf	xxx_ATT_STATS_TYPE	1	Low frequency roll axis statistics
pitch_axis_lf	xxx_ATT_STATS_TYPE	1	Low frequency pitch axis statistics
yaw_axis_lf	xxx_ATT_STATS_TYPE	1	Low frequency yaw axis statistics
roll_axis_hf	xxx_ATT_STATS_TYPE	1	High frequency roll axis statistics
pitch_axis_hf	xxx_ATT_STATS_TYPE	1	High frequency pitch axis statistics
yaw_axis_hf	xxx_ATT_STATS_TYPE	1	High frequency yaw axis statistics
roll_axis_pr	xxx_ATT_STATS_TYPE	1	Processed roll axis statistics
pitch_axis_pr	xxx_ATT_STATS_TYPE	1	Processed pitch axis statistics
yaw_axis_pr	xxx_ATT_STATS_TYPE	1	Processed yaw axis statistics
ll_time_fwd	xxx_MSCD_STATS_TYPE	1	Line length time statistics, forward scans (msec)
ll_time_rev	xxx_MSCD_STATS_TYPE	1	Line length time statistics, reverse scans (msec)
fhs_time_fwd	xxx_MSCD_STATS_TYPE	1	FHS time statistics, forward scans (msec)
fhs_time_rev	xxx_MSCD_STATS_TYPE	1	FHS time statistics, reverse scans (msec)
shs_time_fwd	xxx_MSCD_STATS_TYPE	1	SHS time statistics, forward scans (msec)

Vdata Name: “LMXsssfnYYDOYHHuuvv.HDR”			
Vdata Class:			
Bytes Per Logical Record: 55			
Number of Records: One record per product scan line (major frame)			
Field Name	**Number Type**	**Count**	**Description**
shs_time_rev	xxx_MSCD_STATS_TYPE	1	SHS time statistics, reverse scans (msec)
nonlin_fwd	xxx_MSCD_STATS_TYPE	1	Nonlinearity at mid-scan statistics, forward scans (microradians)
nonlin_rev	xxx_MSCD_STATS_TYPE	1	Nonlinearity at mid-scan statistics, reverse scans (microradians)
detector_status	int32	7x16	Detector status for all bands
num_act_dets	uint32	1	Number of active detectors
subst_det_status	int32	7x16	Substituted detector status (all bands)
rc_slid	uint32	5	Radiometric correction start scan line identification: interval, scan, scan direction, detector, band
num_rc_segs	uint32	1	Number of RC segments in interval
num_scans_rc_seg	uint32	1	Number of scans per RC segment
num_subsegs	uint32	1	Number of subsegments per RC segment
cal_proc_mode	int32	7	Calibration processing model (per band)
hist_proc[	int32	7	Histogram processing selection parameter (per band)
num_hist_iter	uint32	7	Number of histogram iterations allowed (per band)
rmin	float32	7	Rmin (radiance value to which 0 is set) (per band)

Vdata Name: “LMXsssfnYYDOYHHuuvv.HDR”			
Vdata Class:			
Bytes Per Logical Record: 55			
Number of Records: One record per product scan line (major frame)			
Field Name	**Number Type**	**Count**	**Description**
rmax	float32	7	Rmax (radiance value to which 255 is set) (per band)
lamp_mode	char	1	Internal calibration lamp mode: 'S' - sequencer mode 'P' - primary mode, constant level 'B' - backup mode, constant level
lamp_stat	int32	3	Internal calibration lamp: 0 = lamp not used 1 = lamp is used
ephem	xxx_HDR_EPHEM_TYPE	variable	Ephemeris records
radcorr	Xxx_HDR_RADCORR_TYPE	variable	Radiometric correction records

Table 4-14. HDR Vdata

4.3.5 Calculated Gains and Biases (CGB) File (TM-A format)

Table 4-15 lists the contents of the CGB Vdata file.

Vdata Name: “LMXsssfnYYDOYHHuuvv.CGB”			
Vdata Class:			
Bytes Per Logical Record: 55			
Number of Records: One record per product scan line (major frame)			
Field Name	**Number Type**	**Count**	**Description**
cal_lamp_quality	uint8	1	Calibration lamp value quality: 0 = good 1 = not used 2 = not available
comp_cal_lamp_state	uint8	1	Computed calibration lamp state; normally one of eight (1-8) or undefined (9)
comp_cal_lamp_val	float32	1	Computed cal lamp value
comp_shutter_val	float32	1	Computed shutter value

Vdata Name: “LMXsssfnYYDOYHHuuvv.CGB”			
Vdata Class:			
Bytes Per Logical Record: 55			
Number of Records: One record per product scan line (major frame)			
Field Name	**Number Type**	**Count**	**Description**
gain	float32	1	Cal lamp gain value, computed in the cal lamp bias value
bias	float32	1	Cal lamp bias value, computed in the cal lamp bias value
applied_gain	float32	1	Applied gain value; final value used to compute the Response Linearization Look Up Table (RLUTs) after scene content correction (if applied) and blending
applied_bias	float32	1	Applied bias value; final value used to compute the RLUTs after scene content correction (if applied) and blending

Table 4-15. CGB Vdata

4.3.6 Metadata Definitions

Two metadata files (MTA and MTP) accompany an L0Rp data set. These files are structured using the ODL syntax as ASCII text blocks. One of the files describes the interval used to create an L0R product. The second file describes the contents of the L0R product.

4.3.6.1 ODL Conventions

All metadata are stored as ASCII text using the ODL syntax developed by the Jet Propulsion Laboratory (JPL). ODL is a tagged keyword language developed to provide a human-readable data structure to encode data for simplified interchange. Parameters defined by the ODL syntax can be logically grouped to aid in file organization and efficient parsing by software interpreters. For ODL details, refer to the Planetary Data System Standards Reference, Chapter 12, “Object Description Language Specification and Usage,” (see References).

The ODL syntax employs the following conventions:

- Parameter definition is in the form of parameter = value.
- One parameter definition per line.
- Blank spaces and lines are ignored.
- A carriage return <CR> and line feed <LF> end each line in the file.
- Each line of comments must begin with the character /* and end with the character */, including comments embedded on the same line as a parameter definition.

- Quotation marks are required for values that are text strings, including single characters. Reference marks do not add to overall byte size of the values they surround.
- Exceptions to this rule are the GROUP, END_GROUP, OBJECT, and END_OBJECT.
- Identifiers or values, which do not use quotation marks.
- Case is not significant, but uppercase is used for parameter and group names to aid in readability.
- Indentation is not significant, but is used for readability.
- The reserve word END concludes the file.

4.3.6.2 Interval Metadata

During LACS processing, metadata are generated that characterize the interval's spatial extent, content, and data quality. The interval metadata file is the MTA file. The TM subsetter reads the LACS metadata files to generate an ODL interval metadata file. Each scene is a logically separated metadata group containing identification information such as scene center and corner coordinates along with information on the image data. Up to 35 full scene groups may occur for a 14-minute maximum TM contact period.

Vdata Name: "LMXsssfnYYDOYHHuuvv.MTA"			
Vdata Class: LACS_Metadata			
Interlace Type: FULL_INTERLACE			
Bytes Per Logical Record:			
Number of Records: Up to two records.			
Field Name: Metadata_Format			
Parameter Name	**Size (ASCII Bytes)**	**Value, Format, Range and Units**	**Parameter Description/Remarks**
GROUP	13	= METADATA_FILE	Beginning of the first level ODL group. It indicates the start of the L0Rp Metadata File Level Group records for a TM interval.
GROUP	18	= METADATA_FILE_INFO	Beginning of the second level ODL group. It indicates the start of the L0Rp Metadata File Information Group records.
FILE_NAME	22	= "LMXsssfnYYDOYHHuuvv.xxx" where xxx = "MTA" for the metadata file	

Vdata Name: "LMXsssfnYYDOYHHuuvv.MTA"			
Vdata Class: LACS_Metadata			
Interlace Type: FULL_INTERLACE			
Bytes Per Logical Record:			
Number of Records: Up to two records.			
Field Name: Metadata_Format			
Parameter Name	**Size (ASCII Bytes)**	**Value, Format, Range and Units**	**Parameter Description/Remarks**
FILE_CREATION _DATE_TIME	20	= YYYY-MM-DDThh:mm:ssZ where YYYY = Four-digit Julian year (e.g.,1998 and 2001) MM = Month number of a Julian year (01–12 for January to December) DD = Day of a Julian month (01–31) T = Start of time information in the ODL time code format hh = Hours (00–23) mm = Minutes (00–59) ss = Seconds (00–59) Z = "Zulu" time (same as GMT)	Date and time that the full interval metadata file was created. This is equivalent to the time the scene was subsetted.
FILE_VERSION _NO	2	00-99, where 00 indicates "not a reprocessed file in LACS." 01-99 indicates the file reprocess count.	The reprocessing information is determined by reading the interval_id_ver in the LACS metadata.dat file.
STATION_ID	3	=SSS, where SSS indicates a three-character ground station code. XXX indicates the station is not identified.	This parameter identifies the Landsat Ground Station that received the raw data. This parameter is determined by reading the 20-22nd characters in the landsat_interval_id in the LACS metadata.dat file.
SOFTWARE_ VERSION_NO	6	lts_xxx where xxx = the lts version number represented as an integer.	The lts_sw_version from the lacs metadata.dat file.
LM_CPF_NAME	25	="LMCPFyyyymmdd_–yyyymmdd.nn", where L = Landsat M = TM Mission (4 or 5) yyyymmdd = effective_date_begin and effective_date_end, respectively nn= Incrementing version number for within a quarter (00–99)	The name of the Landsat 4/5 CPF received from IAS and used in generating the L0Rp files identified in this metadata file.
END_GROUP	18	= METADATA_FILE_INFO	End of the second level ODL group. It indicates the end of the L0RP Metadata File Information Group records.

Vdata Name: "LMXsssfnYYDOYHHuuvv.MTA"			
Vdata Class: LACS_Metadata			
Interlace Type: FULL_INTERLACE			
Bytes Per Logical Record:			
Number of Records: Up to two records.			
Field Name: Metadata_Format			
Parameter Name	**Size (ASCII Bytes)**	**Value, Format, Range and Units**	**Parameter Description/Remarks**
GROUP	26	SUBINTERVAL_METADATA_ FMT	Beginning of the second level ODL group. It indicates the start of the TM subinterval metadata group records.
SPACECRAFT_ID	8	= Landsat 4 or 5	
SENSOR_ID	2	TM	
CONTACT_PERIOD_START_TIME	18	YYYY-DOYTHH:MM:SSZ where YYYY = Four-digit Julian year DOY = Julian day of year (001–366) T = Start of time information in the ODL ASCII time code format HH = Hour of day (00–23) MM = Minutes (00–59) SS = Seconds (00–59) Z = “Zulu” time (same as GMT) The SUBINTERVAL_START_TIME is used if the contact start time is not recorded.	The Julian date and GMT when the capture of a Landsat 4/5 contact period, associated with this subinterval, was started by LACS Transcription System (LTS). An uppercase time format indicates time obtained from the Landsat 4/5 system. A lowercase time format indicates time obtained from the Landsat 4/5 spacecraft wideband data (image and/or PCD).
CONTACT_PERIOD_STOP_TIME	18	YYYY-DOYTHH:MM:SSZ (See CONTACT_PERIOD_ START_TIME, above) The SUBINTERVAL_STOP_TIME is used if the contact stop time is not recorded.	The Julian date and GMT when capture of a contact period, associated with this subinterval, was completed by LTS.
STARTING_PATH	3	= 001–233 (leading 0s are required)	The WRS path number for the scenes included in this subinterval.
STARTING_ROW	3	= 001–248 (leading 0s are required)	The starting WRS row number for the scene data included in this subinterval.
ENDING_ROW	3	= 001–248 (leading 0s are required)	The ending WRS row number for the scene data included in this subinterval.

Vdata Name: "LMXsssfnYYDOYHHuuvv.MTA"			
Vdata Class: LACS_Metadata			
Interlace Type: FULL_INTERLACE			
Bytes Per Logical Record:			
Number of Records: Up to two records.			
Field Name: Metadata_Format			
Parameter Name	**Size (ASCII Bytes)**	**Value, Format, Range and Units**	**Parameter Description/Remarks**
SUBINTERVAL_ START_TIME	26	= YYYY-dddThh:mm:ss.ttttttZ where YYYY = Four-digit Julian year ddd = Day (001–366*) T = Start of time information in the ODL ASCII time code format hh = Hours (00–23) mm = Minutes (00–59) ss = Seconds (00–59) ttttttt = Fractional seconds (0–9999375, where the clock cycle is 1/16 ms) Z = “Zulu” time (same as GMT) * For cases when active imaging occurs past the end of a leap year during a single contact period.	The spacecraft time extracted from the timecode minor frames of the first TM major frame of the subinterval reported in this file. A computed start time is provided if the timecode in the first TM major frame is in error.
SUBINTERVAL_ STOP_TIME	26	= YYYY-dddThh:mm:ss.ttttttZ where the time format is the same as for SUBINTERVAL_START_ TIME, above.	The spacecraft time extracted from the timecode minor frames of the last TM major frame of the subinterval reported in this file.
TOTAL_TM_SC ANS	1-5	The number of scans in the TM interval.	This information comes from interval_scans from the LACS metadata.dat file.
PCD_START_TI ME	26	= YYYY-dddThh:mm:ss.ttttttZ where the time format is the same as for SUBINTERVAL_START_ TIME, above.	Spacecraft time of the first PCD major frame in the PCD file associated with this subinterval.
PCD_STOP_TI ME	26	= YYYY-dddThh:mm:ss.ttttttZ where the time format is the same as for SUBINTERVAL_START_ TIME, above.	Spacecraft time of the last PCD major frame in the PCD file associated with this subinterval.
TOTAL_PCD_M AJOR_FRAMES	1-3	0-255	The total number of PCD major frames received in the PCD file associated with this subinterval.

Vdata Name: "LMXsssfnYYDOYHHuuvv.MTA"			
Vdata Class: LACS_Metadata			
Interlace Type: FULL_INTERLACE			
Bytes Per Logical Record:			
Number of Records: Up to two records.			
Field Name: Metadata_Format			
Parameter Name	**Size (ASCII Bytes)**	**Value, Format, Range and Units**	**Parameter Description/Remarks**
SUBINTERVAL_UL _CORNER_LAT	8	= –90.0000 through 90.0000 degrees (with a four-digit precision) A positive value indicates north latitude. A negative (–) value indicates south latitude.	Calculated latitude value (degrees) for the upper left corner. A positive (+) value indicates North latitude. A negative (-) value indicates South latitude.
SUBINTERVAL_UL _CORNER_LON	9	= –180.0000 through 180.0000 degrees (with a four-digit precision) A positive value indicates east longitude. A negative (–) value indicates west longitude.	Calculated longitude value (degrees) for the upper left corner. A positive value (+) indicates East longitude. A negative (-) value indicates West longitude.
SUBINTERVAL_UR_CORNER_LAT	8	= –90.0000 through 90.0000 degrees (with a four-digit precision) A positive value indicates north latitude. A negative (–) value indicates south latitude.	Calculated latitude value (degrees) for the upper right corner. A positive (+) value indicates North latitude. A negative (-) value indicates South latitude.
SUBINTERVAL_UR_CORNER_LON	9	= –180.0000 through 180.0000 degrees (with a four-digit precision) A positive value indicates east longitude. A negative (–) value indicates west longitude.	Calculated longitude value (degrees) for the upper right corner. A positive value (+) indicates East longitude. A negative (-) value indicates West longitude.
SUBINTERVAL_LL_ CORNER_LAT	8	= –90.0000 through 90.0000 degrees (with a four-digit precision) A positive value indicates north latitude. A negative (–) value indicates south latitude.	Calculated latitude value (degrees) for the lower left corner. A positive (+) value indicates North latitude. A negative (-) value indicates South latitude.
SUBINTERVAL_LL_ CORNER_LON	9	= –180.0000 through 180.0000 degrees (with a four-digit precision) A positive value indicates east longitude. A negative (–) value indicates west longitude.	Calculated longitude value (degrees) for the lower left corner. A positive value (+) indicates East longitude. A negative (-) value indicates West longitude.
SUBINTERVAL_LR_ CORNER_LAT	8	= –90.0000 through 90.0000 degrees (with a four-digit precision) A positive value indicates north latitude.	Calculated latitude value (degrees) for the lower right corner. A positive (+) value

Vdata Name: "LMXsssfnYYDOYHHuuvv.MTA"			
Vdata Class: LACS_Metadata			
Interlace Type: FULL_INTERLACE			
Bytes Per Logical Record:			
Number of Records: Up to two records.			
Field Name: Metadata_Format			
Parameter Name	**Size (ASCII Bytes)**	**Value, Format, Range and Units**	**Parameter Description/Remarks**
		A negative (–) value indicates south latitude.	indicates North latitude. A negative (-) value indicates South latitude.
SUBINTERVAL_LR_CORNER_LON	9	= –180.0000 through 180.0000 degrees (with a four-digit precision) A positive value indicates east longitude. A negative (–) value indicates west longitude.	Calculated longitude value (degrees) for the lower right corner. A positive value (+) indicates East longitude. A negative (-) value indicates West longitude.
UT1_CORRECTION	8	= –0.90000–0.90000 seconds This time could be as large as 0.9 seconds in increments of fractions of seconds.	The Universal Time Code (UTC)-UTC Corrected (UT1) time difference in seconds obtained from the Landsat 4/5 CPF received.
BAND1_PRESENT	1	= "Y" indicates that Band 1 is present in this subinterval or = "N" indicates that Band 1 is not present in this subinterval or = "" (i.e., quote followed by a quote) indicates data corruption in the PCD major frame. This field is included in the subinterval metadata only.	This is the "Band 1 ON" status information obtained from PCD serial word "B" (major frame (2), minor frame 32, word 72), bit 0, where a bit set condition (=1) indicates "Band 1 ON state." The first error-free PCD major frame (2), found in the subinterval, is used to derive this value.
BAND2_PRESENT	1	(Same as BAND1_PRESENT values and format.) This field is included in the subinterval metadata only.	This is the "Band 2 ON" status information obtained from PCD serial word "B" (major frame (2), minor frame 32, word 72), bit 1, where a bit set condition (=1) indicates "Band 2 ON state." The first error-free PCD major frame (2) is used to derive this value.
BAND3_PRESENT	1	(Same as BAND1_PRESENT values and format.) This field is included in the subinterval metadata only.	This is the "Band 3 ON" status information obtained from PCD serial word "B" (major frame (2), minor frame 32, word 72), bit 2, where a bit set condition (=1) indicates "Band 3 ON state." The first error-

Vdata Name: "LMXsssfnYYDOYHHuuvv.MTA"			
Vdata Class: LACS_Metadata			
Interlace Type: FULL_INTERLACE			
Bytes Per Logical Record:			
Number of Records: Up to two records.			
Field Name: Metadata_Format			
Parameter Name	**Size (ASCII Bytes)**	**Value, Format, Range and Units**	**Parameter Description/Remarks**
			free PCD major frame (2), found in the subinterval, is used to derive this value.
BAND4_PRESENT	1	(Same as BAND1_PRESENT values and format.) This field is included in the subinterval metadata only.	This is the "Band 4 ON" status information obtained from PCD serial word "B" (major frame (2), minor frame 32, word 72), bit 3, where a bit set condition (=1) indicates "Band 4 ON state." The first error-free PCD major frame (2), found in the subinterval, is used to derive this value.
BAND5_PRESENT	1	(Same as BAND1_PRESENT values and format.) This field is included in the subinterval metadata only.	This is the "Band 5 ON" status information obtained from PCD serial word "B" (major frame (2), minor frame 32, word 72), bit 4, where a bit set condition (=1) indicates "Band 5 ON state." The first error-free PCD major frame (2), found in the subinterval, is used to derive this value.
BAND6_PRESENT	1	(Same as BAND1_PRESENT values and format.) This field is included in the subinterval metadata only.	This is the "Band 6/MIR ON" status information obtained from PCD serial word "B" (major frame (2), minor frame 32, word 72), bit 5, where a bit set condition (=1) indicates "Band 6 ON state." The first error-free PCD major frame (2), found in the subinterval, is used to derive this value.
BAND7_PRESENT	1	(Same as BAND1_PRESENT values and format.) This field is included in the subinterval metadata only.	This is the "Band 7 ON" status information obtained from PCD serial word "B" (major frame (2), minor frame 32, word 72), bit 6, where a bit set condition (=1) indicates "Band 7 ON state." The first error-

Vdata Name: "LMXsssfnYYDOYHHuuvv.MTA"			
Vdata Class: LACS_Metadata			
Interlace Type: FULL_INTERLACE			
Bytes Per Logical Record:			
Number of Records: Up to two records.			
Field Name: Metadata_Format			
Parameter Name	**Size (ASCII Bytes)**	**Value, Format, Range and Units**	**Parameter Description/Remarks**
			free PCD major frame (2), found in the subinterval, is used to derive this value.
TOTAL_WRS_ SCENES	1-2	= 0–99 This field is included in both metadata files.	This count indicates the total number of WRS scenes identified in an interval. A maximum of 35 full WRS scenes, including partial scenes at the start and/or the end of an interval, may be received in a 14-minute interval.
PARTIAL_WRS _ SCENES	1	= 0–2 This field is included in subinterval metadata.	Indicates the count of partial scenes, if any, at the start and/or end of a subinterval.
TOTAL_FILES	1-2	= 10–17	The total number of files included in this subinterval for TM. This assumes that a subinterval contains at least one scene, the metadata file contains the names of a minimum of 10 files (7 band, 1 MSCD, 1 PCD, 1 calibration)
BAND1_FILE_N AME	23	= “LMXsssfnYYDOYHHuuvv.B10”	This file name is used to label the Band 1 SDS in the L0Rp data. In addition, the product's Band 1 file name root is constructed from this character string.
BAND2_FILE_N AME	23	= “LMXsssfnYYDOYHHuuvv.B20”	This file name is used to label the Band 2 SDS in the L0Rp data. In addition, the product's Band 2 file name root is constructed from this character string.
BAND3_FILE_N AME	23	= “LMXsssfnYYDOYHHuuvv.B30”	This file name is used to label the Band 3 SDS in the L0Rp data. In addition, the product's Band 3 file name root is

Vdata Name: "LMXsssfnYYDOYHHuuvv.MTA"			
Vdata Class: LACS_Metadata			
Interlace Type: FULL_INTERLACE			
Bytes Per Logical Record:			
Number of Records: Up to two records.			
Field Name: Metadata_Format			
Parameter Name	**Size (ASCII Bytes)**	**Value, Format, Range and Units**	**Parameter Description/Remarks**
			constructed from this character string.
BAND4_FILE_NAME	23	= “LMXsssfnYYDOYHHuuvv.B40”	This file name is used to label the Band 4 SDS in the L0Rp data. In addition, the product's Band 4 file name root is constructed from this character string.
BAND5_FILE_NAME	23	= “LMXsssfnYYDOYHHuuvv.B50”	This file name is used to label the Band 5 SDS in the L0Rp data. In addition, the product's Band 5 file name root is constructed from this character string.
BAND6_FILE_NAME	23	= “LMXsssfnYYDOYHHuuvv.B60”	This file name is used to label the Band 6 SDS in the L0Rp data. In addition, the product's Band 6 file name root is constructed from this character string.
BAND7_FILE_NAME	23	= “LMXsssfnYYDOYHHuuvv.B70”	This file name is used to label the Band 7 SDS in the L0Rp data. In addition, the product's Band 7 file name root is constructed from this character string.
MSCD_FILE_NAME	23	= “LMXsssfnYYDOYHHuuvv.MSD” (See Section 4.3.1 for details.)	Name of the MSCD file associated with this subinterval.
PCD_FILE_NAME	23	= “LMXsssfnYYDOYHHuuvv.PCD” (See Section 4.3.1 for details.)	Name of the PCD file associated with this subinterval.
CAL_FILE_NAME	23	= “LMXsssfnYYDOYHHuuvv.CAL” (See Section 4.3.1 for details.)	Name of the calibration file associated with this subinterval. The root of this file name is used for constructing the calibration data SDS name (s) in the distribution product. The root

Vdata Name: "LMXsssfnYYDOYHHuuvv.MTA"			
Vdata Class: LACS_Metadata			
Interlace Type: FULL_INTERLACE			
Bytes Per Logical Record:			
Number of Records: Up to two records.			
Field Name: Metadata_Format			
Parameter Name	**Size (ASCII Bytes)**	**Value, Format, Range and Units**	**Parameter Description/Remarks**
			and extension of this file name are used to construct the distribution product's calibration file name root.
Scene-Level Metadata: The following parameter values are repeated for each TM scene included in the subinterval.			
GROUP	17	= METADATA_SCENE_NN where NN = 01–99 (Up to 35 full scenes are expected in a 14-minute subinterval)	Beginning of the second level ODL group. It indicates the beginning of the TM Scene NN level metadata group records.
GROUP	12	= WRS_SCENE_NN where NN = 01–99	Beginning of the third level ODL group. It indicates the beginning of the TM WRS Scene 1 metadata group records.
WRS_SCENE_NO	1-2	1-99	The LACS assigned WRS scene number within a subinterval.
FULL_OR_PARTIAL_SCENE	1	= F or P where F indicates a full WRS scene or P indicates a partial WRS scene at start or end of a subinterval	Partial WRS scenes may exist at the start and/or end of a subinterval.
BROWSE_FILE_NAME		LT5PPPRRRYYYYDOYGSIVV.jpg LT5 = Constant PPP = PATH RRR = ROW YYYY = YEAR DOY = Day of Year GSI = Ground Station VV = Version Number	LACS generated browse file. The actual browse file is not included with the L0Rp data set.
WRS_PATH	3	= 001–233 (Leading zeros are required.)	The WRS path number associated with the scene from PCD scene accounting.
WRS_ROW	3	= 001–248 (Leading zeros are required.)	The WRS row number associated with the scene.

Vdata Name: "LMXsssfnYYDOYHHuuvv.MTA"			
Vdata Class: LACS_Metadata			
Interlace Type: FULL_INTERLACE			
Bytes Per Logical Record:			
Number of Records: Up to two records.			
Field Name: Metadata_Format			
Parameter Name	**Size (ASCII Bytes)**	**Value, Format, Range and Units**	**Parameter Description/Remarks**
SCENE_CENTER_ SCAN_NO	2-5	= 1–11725 (for "actual" scene centers in the subinterval) For a partial scene with less than a half scene length data, the scene center scan number may be outside the actual subinterval band data range. It points to the nonexistent scan 0 in the band file.	The TM scan number nearest the calculated (actual) center of a WRS scene. A WRS scene scan number within a 14-minute subinterval can be as high as 11,725.
SCENE_CENTER_ SCAN_TIME	26	= YYYY-dddThh:mm:ss.ttttttZ where the time format is the same as for SUBINTERVAL_START_ TIME, above.	The spacecraft time associated with a WRS scene center scan (number).
SCENE_CENTER_ LAT	8	= –90.0000 through 90.0000 degrees (with a four-digit precision) A positive value indicates north latitude. A negative (–) value indicates south latitude.	WRS scene center
SCENE_CENTER_ LON	9	= –180.0000 through 180.0000 degrees (with a four-digit precision) A positive value indicates east longitude. A negative (–) value indicates west longitude.	WRS scene center longitude
HORIZONTAL_ DISPLAY_SHIFT	2-56	= – 99999 through 99999 meters A negative (–) value defines a shift of the calculated "true" WRS scene center to the west of the nominal WRS scene center. A positive value defines a shift of the calculated "true" WRS scene center to the east of the nominal WRS scene center. A 0 indicates that the display shift was not computed. Poor ephemeris points may result in a Horizontal Display Shift (HDS) that lies outside of the allowed range. In these cases, the HDS maximums (-99999 or 99999) appear.	Not applicable for Landsat 4-Landsat 5 TM data. This field is 0.
SCENE_UL_ CORNER_LAT	8	= –90.0000 through 90.0000 degrees (with a four-digit precision) A positive value indicates north latitude.	WRS scene upper left corner

Vdata Name: "LMXsssfnYYDOYHHuuvv.MTA"			
Vdata Class: LACS_Metadata			
Interlace Type: FULL_INTERLACE			
Bytes Per Logical Record:			
Number of Records: Up to two records.			
Field Name: Metadata_Format			
Parameter Name	**Size (ASCII Bytes)**	**Value, Format, Range and Units**	**Parameter Description/Remarks**
		A negative (–) value indicates south latitude.	
SCENE_UL_ CORNER_LON	9	= –180.0000 through 180.0000 degrees (with a four-digit precision) A positive value indicates east longitude. A negative (–) value indicates west longitude.	WRS scene upper left corner
SCENE_UR_ CORNER_LAT	8	= –90.0000 through 90.0000 degrees (with a four-digit precision) A positive value indicates north latitude. A negative (–) value indicates south latitude.	WRS scene upper right corner
SCENE_UR_ CORNER_LON	9	= –180.0000 through 180.0000 degrees (with a four-digit precision). A positive value indicates east longitude. A negative (–) value indicates west longitude.	WRS scene upper right corner
SCENE_LL_ CORNER_LAT	8	= –90.0000 through 90.0000 degrees (with a four-digit precision). A positive value indicates north latitude. A negative (–) value indicates south latitude.	WRS scene lower left corner
SCENE_LL_ CORNER_LON	9	= –180.0000 through 180.0000 degrees (with a four-digit precision). A positive value indicates east longitude. A negative (–) value indicates west longitude.	WRS scene lower left corner
SCENE_LR_ CORNER_LAT	8	= –90.0000 through 90.0000 degrees (with a four-digit precision). A positive value indicates north latitude. A negative (–) value indicates south latitude.	WRS scene lower right corner
SCENE_LR_ CORNER_LON	9	= –180.0000 through 180.0000 degrees (with a four-digit precision). A positive value indicates east longitude. A negative (–) value indicates west longitude.	WRS scene lower right corner
SCENE_CCA	1–3	= 0–100; This field is included in the subinterval metadata only.	The cloud assessment scores are listed in the metadata.lis file per scene.

Vdata Name: "LMXsssfnYYDOYHHuuvv.MTA"			
Vdata Class: LACS_Metadata			
Interlace Type: FULL_INTERLACE			
Bytes Per Logical Record:			
Number of Records: Up to two records.			
Field Name: Metadata_Format			
Parameter Name	**Size (ASCII Bytes)**	**Value, Format, Range and Units**	**Parameter Description/Remarks**
UL_QUAD_CCA	1–3	= 0–100 or NA; This field is included in the subinterval metadata only.	The cloud assessment scores for quadrants are located in the metadata.lis file.
LR_QUAD_CCA	1–3	= 0–100 or NA; This field is included in the subinterval metadata only.	The cloud assessment scores for quadrants are located in the metadata.lis file.
UR_QUAD_CCA	1–3	= 0–100 or NA; This field is included in subinterval metadata only.	The cloud assessment scores for quadrants are located in the metadata.lis file.
LL_QUAD_CCA	1–3	= 0–100 or NA; This field is included in the subinterval metadata only.	The cloud assessment scores for quadrants are located in the metadata.lis file.
ACCA_ALGORITHM_ID_VER	5	= Five ASCII characters; XXX.X appears if ACCA is not performed; otherwise the version is filled in.	Taken from the LACS metadata.lis file acca_algorithm.
SUN_AZIMUTH_ANGLE	12	= –180.0000000 through 180.0000000 degrees (with seven-digit precision); a positive value indicates angles to the east or clockwise from north. A negative value (–) indicates angles to the west or counterclockwise from north. (Leading zeros are not required.)	The Sun azimuth angle at the "true" WRS scene.
SUN_ELEVATION_ANGLE	11	= –90.0000000 through 90.0000000 degrees (with seven-digit precision); a positive value indicates a daytime scene. A negative value (–) indicates a nighttime scene. (Leading zeros are not required.)	The Sun elevation angle at the "true" WRS scene.
SCENE_BAND1_PRESENT	1	= "Y" indicates that Band 1 is present = "N" indicates that Band 1 is not present = "U" indicates that Band 1 presence is unknown; this field is included in the subinterval metadata only	This is the "Band 1 ON" state information obtained from PCD serial word "B" (major frame (2), minor frame 32, word 72), bit 0, where a bit set condition (=1) indicates "Band 1 ON state." The first error-free PCD major frame (2) associated with the scene is used to derive this value. If no valid PCD major frame falls within the scene's time

Vdata Name: "LMXsssfnYYDOYHHuuvv.MTA"			
Vdata Class: LACS_Metadata			
Interlace Type: FULL_INTERLACE			
Bytes Per Logical Record:			
Number of Records: Up to two records.			
Field Name: Metadata_Format			
Parameter Name	**Size (ASCII Bytes)**	**Value, Format, Range and Units**	**Parameter Description/Remarks**
			boundary, then the value for the previous scene is used. If the previous scene has no valid major frame (e.g., the first partial scene in a subinterval), then the value "U" for unknown is used.
SCENE_BAND2_PRESENT	1	= "Y" indicates that Band 1 is present = "N" indicates that Band 1 is not present = "U" indicates that Band 1 presence is unknown; this field is included in the subinterval metadata only	Same as above with the exception as noted. This is the "Band 2 ON" status information obtained from PCD serial word "B" (major frame (2), minor frame 32, word 72), bit 1, where a bit set condition (=1) indicates "Band 2 ON state."
SCENE_BAND3_PRESENT	1	= "Y" indicates that Band 1 is present = "N" indicates that Band 1 is not present = "U" indicates that Band 1 presence is unknown; this field is included in the subinterval metadata only	Same as above with the exception as noted. This is the "Band 3 ON" status information obtained from PCD serial word "B" (major frame (2), minor frame 32, word 72), bit 2, where a bit set condition (=1) indicates "Band 3 ON state."
SCENE_BAND4_PRESENT	1	= "Y" indicates that Band 1 is present = "N" indicates that Band 1 is not present = "U" indicates that Band 1 presence is unknown; this field is included in the subinterval metadata only	Same as above with the exception as noted. This is the "Band 4 ON" status information obtained from PCD serial sord "B" (major frame (2), minor frame 32, word 72), bit 3, where a bit set condition (=1) indicates "Band 4 ON state."
SCENE_BAND5_PRESENT	1	= "Y" indicates that Band 1 is present = "N" indicates that Band 1 is not present = "U" indicates that Band 1 presence is unknown; this field is included in the subinterval metadata only	Same as above with the exception as noted. This is the "Band 5 ON" status information obtained from PCD serial word "B" (major frame (2), minor frame 32,

Vdata Name: "LMXsssfnYYDOYHHuuvv.MTA"			
Vdata Class: LACS_Metadata			
Interlace Type: FULL_INTERLACE			
Bytes Per Logical Record:			
Number of Records: Up to two records.			
Field Name: Metadata_Format			
Parameter Name	**Size (ASCII Bytes)**	**Value, Format, Range and Units**	**Parameter Description/Remarks**
			word 72), bit 4, where a bit set condition (=1) indicates "Band 5 ON state."
SCENE_BAND6_PRESENT	1	= "Y" indicates that Band 1 is present = "N" indicates that Band 1 is not present = "U" indicates that Band 1 presence is unknown; this field is included in the subinterval metadata only	Same as above with the exception as noted. This is the "Band 6/MIR ON" status information obtained from PCD serial word "B" (major frame (2), minor frame 32, word 72), bit 5, where a bit set condition (=1) indicates "Band 6 ON state."
SCENE_BAND7_PRESENT	1	= "Y" indicates that Band 1 is present = "N" indicates that Band 1 is not present = "U" indicates that Band 1 presence is unknown; this field is included in the subinterval metadata only	Same as above with the exception as noted. This is the "Band 7 ON" status information obtained from PCD serial word "B" (major frame (2), minor frame 32, word 72), bit 6, where a bit set condition (=1) indicates "Band 7 ON state." The band gain condition detected at the start of a WRS scene. (See parameter description for BAND1_GAIN.)
DAY_NIGHT_FLAG	1	= "D" for day flag ‘True’ or = "N" for night flag ‘True’	This field indicates the day or night condition for the scene. The day / night condition of a scene is determined by comparing the Sun elevation values against an angle value of 0 degrees. A scene is declared a day scene if the Sun elevation angle is greater than 0 degrees; otherwise, it is declared a night scene.
END_GROUP	12	= WRS_SCENE_NN where NN = 01–99 (Up to 35 full scenes are expected to be	End of the third level ODL group. It indicates the end of the TM WRS scene metadata group records.

Vdata Name: "LMXsssfnYYDOYHHuuvv.MTA"			
Vdata Class: LACS_Metadata			
Interlace Type: FULL_INTERLACE			
Bytes Per Logical Record:			
Number of Records: Up to two records.			
Field Name: Metadata_Format			
Parameter Name	**Size (ASCII Bytes)**	**Value, Format, Range and Units**	**Parameter Description/Remarks**
		received by LPS in a 14-minute subinterval)	
GROUP	8	= TM_QA_NN where NN = 01–99	Beginning of the third level ODL group. It indicates the beginning of the TM scene NN QA data group records.
SCENE_QUALITY	2	= 00–99, –1	The first digit represents the overall scene image quality; the second digit represents PCD quality. A 99 represents the highest quality and a 00 represents the lowest quality. A –1 occurs if no scene quality score was obtained. The scene quality is determined by the mean of all band quality scores from the metadata.lis file.
IMG_MJR_FRAMES	1-32	Number of major frames or scan lines. One entry per band in the format [and1,band2,band3…band7]	img_mjr_frm from the LACS metadata.dat file. Normal full scenes are 374 scan lines.
IMG_MNR_FRAMES	1-60	Number of scene minor frames. One entry per band in the format [band1,band2,band3…band7]	img_mnr_frm from the LACS metadata.dat file.
IMG_BAD_MNR_FRAMES	1-60	Number of bad minor frames for this scene. One entry per band in the format [band1,band2,band3…band7]	img_bad_mnr_frm from the LACS file metadata.dat file.
IMG_FLYWHEEL	1–60	Number of image minor frames flywheeled. One entry per band in the format [band1,band2,band3…band7]	Img_flywheel from the LACS metadata.dat file.
IMG_PATTERN_ERR	1-60	Number of image pattern errors. One entry per band in the format [band1,band2,band3…band7]	Img_pattern_err from the LACS metadata.dat file.
IMG_BIT_SLIPS	1–60	Number of image bit slips. One entry per band in the format [band1,band2,band3…band7]	Img_bit_slips from the LACS metadata.dat file.

Vdata Name: "LMXsssfnYYDOYHHuuvv.MTA"			
Vdata Class: LACS_Metadata			
Interlace Type: FULL_INTERLACE			
Bytes Per Logical Record:			
Number of Records: Up to two records.			
Field Name: Metadata_Format			
Parameter Name	**Size (ASCII Bytes)**	**Value, Format, Range and Units**	**Parameter Description/Remarks**
END_GROUP	9	TM_QA_NN	End of the third level ODL group. It indicates the end of the TM WRS scene metadata group records.
END_GROUP	17	= METADATA_SCENE_NN where NN = 01–99 (Up to 35 full scenes are expected to be received by LPS in a 14-minute subinterval.)	End of the second level ODL group. It indicates the end of the TM scene NN level metadata group records.
END_GROUP	26	= SUBINTERVAL_METADATA_FMT	End of the second level ODL group. It indicates the end of the TM subinterval level metadata group records.
END_GROUP	13	= METADATA_FILE	End of the first level ODL group. It indicates the end of the LACS metadata file level group records for a TM subinterval.
END			Required standalone parameter signifying file end.

Table 4-16. Interval Metadata File Contents - ODL Parameter Values

4.3.6.3 MTP

The second metadata file, also an external element, is created during product generation and contains information specific to the product ordered such as corner coordinates and external element file names. The product metadata file is the MTP file. Table 4-17 lists the full content of the distribution product metadata file.

Vdata Name: “LMXsssfnYYDOYHHuuvv.MTP”			
Vdata Class: Product_Metadata			
Interlace Type: FULL_INTERLACE			
Number of Records: One record			
Field Name: Metadata_Product_Specific			
Parameter Name	**Size (ASCII bytes)**	**Value, Format, Range, and Units**	**Parameter Description/Remarks**
GROUP	17	= L0RP_METADATA_FILE	Beginning of the first level ODL group. It indicates the start of the metadata file level group.
GROUP	18	= METADATA_FILE_INFO	Beginning of the metadata file information group.
ORIGIN	47	= "Image courtesy of the U.S. Geological Survey"	Establishes the origin of the image to be from the USGS.
PRODUCT_CREATION_DATE_TIME	20	= YYYY-MM-DDThh:mm:ssZ where YYYY = Four-digit Julian year (e.g., 1998 and 2001) MM = Month number of a Julian year (01–12 for January to December) DD = Day of a Julian month (01–31) T = Start of time information in the ODL ASCII time code format hh = Hours (00–23) mm = Minutes (00–59) ss = Seconds (00–59) Z = "Zulu" time (same as GMT)	The system date and time when the metadata file for an L0Rp data set was created. For ease of human readability, this date and time information is presented in the ODL ASCII format. The time is expressed as UTC (also known as GMT). Insertion of additional characters "T" and "Z" is required to meet the ODL ASCII time format.
STATION_ID	3	= "SSS" where SSS = EDC, AGS, SGS, or international station symbol	Unique three-letter code identifying the origination ground station.
END_GROUP	18	= METADATA_FILE_INFO	End of the metadata information group.
GROUP	16	= PRODUCT_METADATA	Beginning of the product metadata group.
PRODUCT_TYPE	3	= "L0Rp"	Type of product as opposed to Level 1 Radiometrically corrected (L1R).
SPACECRAFT_ID	8	= "Landsat5"	Name of the satellite platform.
SENSOR_ID	4	= "TM"	Name of the imaging sensor.
SENSOR_MODE	6	= “SAM” = “BUMPER”	Scan Angle Monitor Mode (SAM) and Bumper Mode (BUMPER).

Vdata Name: "LMXsssfnYYDOYHHuuvv.MTP"			
Vdata Class: Product_Metadata			
Interlace Type: FULL_INTERLACE			
Number of Records: One record			
Field Name: Metadata_Product_Specific			
Parameter Name	**Size (ASCII bytes)**	**Value, Format, Range, and Units**	**Parameter Description/Remarks**
ACQUISITION_DATE	10	YYYY-MM-DD where (see data and time convention above)	Date the image was acquired. The value in the case of Subinterval product is to be derived from modification (datetime to date) of the value from SUBINTERVAL_ START_TIME, and the value in the case of scene product is to be derived from modification of SCENE_CENTER_SCAN_ TIME.
STARTING_PATH	3	= NNN, where NNN = Path number	Starting WRS path value for the product.
STARTING_ROW	3	= NNN, where NNN = Row of the first full or partial scene in the product	Starting WRS row.
ENDING_ROW	3	= NNN, where NNN = Row of the last full or partial scene in the product	Ending WRS row.
TOTAL_ WRS_ SCENES	5	= NN.NN, where NN.NN = Number of full and partial scenes encapsulated by the product	Maximum number is 36.99 for a subinterval product.
NUMBER_OF_SCANS	5	= NNNNN, where NNNNN = 90–12410	Total number of scans in the product.
STARTING_SUBINTERVAL_ SCAN	5	= NNNNN, where NNNNN = 1–12321	Product starting scan number referenced relative to the parent subinterval.
ENDING_SUBINTERVAL_ SCAN	5	= NNNNN, where NNNNN = 90–12410	Product ending scan number referenced relative to the parent subinterval.
BAND_COMBINATION	7	"NNNNNNN", where "NNNNNNN" = e.g. 1234567 for all bands present, 123----- 7 for Bands 1,2,3,7. A '-' is a position holder for absent bands.	Bands present indicator for the product ordered.

Vdata Name: "LMXsssfnYYDOYHHuuvv.MTP"			
Vdata Class: Product_Metadata			
Interlace Type: FULL_INTERLACE			
Number of Records: One record			
Field Name: Metadata_Product_Specific			
Parameter Name	**Size (ASCII bytes)**	**Value, Format, Range, and Units**	**Parameter Description/Remarks**
PRODUCT_UL_CORNER_ LAT	8	= –90.0000 through +90.0000 degrees (with a four-digit precision) A positive (+) value indicates north latitude. A negative (–) value indicates south latitude.	Calculated latitude value for the upper left corner of the product. A LACS-calculated value is used for subinterval and standard WRS scene-based products.
PRODUCT_UL_CORNER_ LON	8	= –180.0000 through +180.0000 degrees (with a four-digit precision) A positive (+) value indicates east longitude. A negative (–) value indicates west longitude.	Calculated longitude value for the upper left corner of the product. A LACS-calculated value is used for subinterval and standard WRS scene-based products.
PRODUCT_UR_CORNER_ LAT	8	= –90.0000 through +90.0000 degrees (with a four-digit precision)	Calculated latitude value for the upper right corner of the product. A LACS-calculated value is used for subinterval and standard WRS scene-based products.
PRODUCT_UR_CORNER_ LON	9	= –180.0000 through +180.0000 degrees (with a four-digit precision)	Calculated longitude value for the upper right corner of the product. A LACS-calculated value is used for subinterval and standard WRS scene-based products.
PRODUCT_LL_CORNER_ LAT	8	= –90.0000 through +90.0000 degrees (with a four-digit precision)	Calculated latitude value for the lower left corner of the product. A LACS-calculated value is used for subinterval and standard WRS scene-based products.
PRODUCT_LL_CORNER_ LON	9	= –180.0000 through +180.0000 degrees (with a four-digit precision)	Calculated longitude value for the lower left corner of the product. A LACS-calculated value is used for subinterval and standard WRS scene-based products.

Vdata Name: "LMXsssfnYYDOYHHuuvv.MTP"			
Vdata Class: Product_Metadata			
Interlace Type: FULL_INTERLACE			
Number of Records: One record			
Field Name: Metadata_Product_Specific			
Parameter Name	**Size (ASCII bytes)**	**Value, Format, Range, and Units**	**Parameter Description/Remarks**
PRODUCT_LR_CORNER_ LAT	8	= –90.0000 through +90.0000 degrees (with a four-digit precision)	Calculated latitude value for the lower right corner of the product. A LACS-calculated value is used for subinterval and standard WRS scene-based products.
PRODUCT_LR_CORNER_ LON	9	= –180.0000 through +180.0000 degrees (with a four-digit precision)	Calculated longitude value for the lower right corner of the product. A LACS-calculated value is used for subinterval and standard WRS scene-based products.
BAND1_FILE_NAME	24	"LMXsss1nYYDOYHHuuvv_B10.YYDOYHHMM" (See Section 4.3.1 for details.)	File name for Band 1.
BAND2_FILE_NAME	24	LMXsss1nYYDOYHHuuvv_B20.YYDOYHHMM" (See Section 4.3.1 for details.)	File name for Band 2.
BAND3_FILE_NAME	24	"LMXsss1nYYDOYHHuuvv_B30.YYDOYHHMM" (See Section 4.3.1 for details.)	File name for Band 3.
BAND4_FILE_NAME	24	"LMXsss1nYYDOYHHuuvv_B40.YYDOYHHMM" (See Section 4.3.1 for details.)	File name for Band 4.
BAND5_FILE_NAME	24	"LMXsss1nYYDOYHHuuvv_B50.YYDOYHHMM" (See Section 4.3.1 for details.)	File name for Band 5.
BAND6_FILE_NAME	24	"LMXsss1nYYDOYHHuuvv_B60.YYDOYHHMM" (See Section 4.3.1 for details.)	File name for Band 6.
BAND7_FILE_NAME	24	"LMXsss2nYYDOYHHuuvv_B70.YYDOYHHMM" (See Section 4.3.1 for details.)	File name for Band 7.

Vdata Name: "LMXsssfnYYDOYHHuuvv.MTP"			
Vdata Class: Product_Metadata			
Interlace Type: FULL_INTERLACE			
Number of Records: One record			
Field Name: Metadata_Product_Specific			
Parameter Name	**Size (ASCII bytes)**	**Value, Format, Range, and Units**	**Parameter Description/Remarks**
IC_DATA_FILE_NAME	24	"LMXsss1nYYDOYHHuuvv_CAL.YYDOYHHMM" (See Section 4.3.1 for details.)	File name for internal calibrator data.
SCAN_OFFSETS_FILE_NAME	24	"LMXsss1nYYDOYHHuuvv_SLO.YYDOYHHMM" (See Section 4.3.1 for details.)	File name for scan line shift data.
MSCD_FILE_NAME	24	"LMXsss1nYYDOYHHuuvv_MSD.YYDOYHHMM" (See Section 4.3.1 for details.)	File name for mirror scan correction data.
PCD_FILE_NAME	24	"LMXsss1nYYDOYHHuuvv_PCD.YYDOYHHMM" (See Section 4.3.1 for details.)	File name for payload correction data.
METADATA_FILE_NAME	24	"LMXsss1nYYDOYHHuuvv_MTA.YYDOYHHMM" (See Section 4.3.1 for details.)	File name for interval-specific metadata.
METADATA_PS_FILE_NAME	24	"LMXsssfnYYDOYHHuuvv_MTP.YYDOYHHMM" (See Section 4.3.1 for details.)	File name for product-specific metadata.
CPF_FILE_NAME	31	"LXSSCPF_YYYYMMDD_yyyymmdd_CC.NN" L = Landsat (constant) X = Instrument (E = ETM, M = MSS, C = OLI/TIRS, etc.) SS = Satellite (e.g., 08 for Landsat 8, 09 for Landsat 9, 10 for Landsat 10) CPF = Three-letter CPF designator YYYYMMDD = Effective starting year (YYYY) / Month (MM) / Day (DD) yyyymmdd = Effective ending year (yyyy) / Month (mm) / Day (dd) CC = Collection number (e.g., 01) NN = Version number for this file (starts with 00)	File name for the IAS calibration parameter file. Note: The version number 00 is reserved exclusively for the prelaunch CPF.

Vdata Name: "LMXsssfnYYDOYHHuuvv.MTP"			
Vdata Class: Product_Metadata			
Interlace Type: FULL_INTERLACE			
Number of Records: One record			
Field Name: Metadata_Product_Specific			
Parameter Name	**Size (ASCII bytes)**	**Value, Format, Range, and Units**	**Parameter Description/Remarks**
GEOLOCATION_FILE_NAME	24	"LMXsss1fnYYDOYHHuuvv_GEO.YYDOYHHMM" (see Section 4.3.1 for details)	File name for the geolocation table.
HDF_DIR_FILE_NAME	24	"LMXsssfnYYDOYHHuuv_HDF" (See Section 4.3.1 for details.)	File name for the HDF directory file.
END_GROUP	16	= PRODUCT_METADATA	End of the product metadata group.
END_GROUP	17	= L0RP_METADATA_FILE	End of the product metadata ODL group.
END			Required standalone parameter signifying file end.

Table 4-17. MTP File Contents - ODL Parameter Values

4.3.7 Annotation File (TM-A Format)

The annotation file contains the tic marks required for mapping scene-based u,v coordinates to projection space. This information is stored in an ODL-formatted file. Table 4-18 describes the contents of the annotation file.

Vdata Name: "LMXsssfnYYDOYHHuuvv.ANN"			
Vdata Class: Annotation_Metadata			
Interlace Type: FULL_INTERLACE			
Number of Records: One record.			
Field Name: Annotation			
Parameter Name	**Size (ASCII bytes)**	**Value, Format, Range, and Units**	**Parameter Description/Remarks**
GROUP		= L0RP_ANNOTATION_FILE	Beginning of the first-level ODL group. It indicates the start of the annotation file level group.
GROUP		= GENERAL_INFO	Beginning of the general information group.
SCENE_CENTER	15		Latitude and longitude at the center of the image format, in degrees and minutes.

Vdata Name: "LMXsssfnYYDOYHHuuvv.ANN"			
Vdata Class: Annotation_Metadata			
Interlace Type: FULL_INTERLACE			
Number of Records: One record.			
Field Name: Annotation			
Parameter Name	**Size (ASCII bytes)**	**Value, Format, Range, and Units**	**Parameter Description/Remarks**
SUN_ANGLES	14		Sun elevation and azimuth angles, measured clockwise from tru north at the midpoint of the MSS / TM frame, to the nearest angle; blank for ascending node coverage.
PROJECTION	1	= X Where: X represents one of the following: L = Lambert P = Polar Stereographic S = Space Oblique Mercator U = Universal Transverse Mercator H = Hotine Oblique Mercator	Image projection.
EPHEMERIS_TYPE	1	= P (predictive) or D (definitive)	Type of ephemeris data used to compute the image center. Definitive used for system-level corrections only.
PROCESSING_PROC	1	= N (normal) or A (abnormal)	Processing procedure.
FRAME_ID	16	= "E-ADDDD-HHMMS-B" Where: E = Encoded Project Identifier A = Landsat mission DDDD = Days since launch at time of observation HH = Hour MM = Minute S = Tens of seconds B = IBF Identification Code (for RBV, use 1,2,3,A,B,C, or D; for MSS, use 4,5,6,7, or 8)	Frame identification number.
END_GROUP		= GENERAL_INFO	End of the general information group.
GROUP		= TICS	Beginning of the tics metadata group.
TOP_LOC	variable	= (NNNN, NNNN, NNNN, ...)	Array of tic mark locations along the top of the scene.
TOP_TIC	variable	= (VNNN, VNNN, VNNN, ...)	Array of coordinate labels along the top of the scene.

Vdata Name: “LMXsssfnYYDOYHHuuvv.ANN”			
Vdata Class: Annotation_Metadata			
Interlace Type: FULL_INTERLACE			
Number of Records: One record.			
Field Name: Annotation			
Parameter Name	**Size (ASCII bytes)**	**Value, Format, Range, and Units**	**Parameter Description/Remarks**
TOP_TICV	variable	= (XXXX.XXX, XXXX.XXX, XXXX.XXX, ...)	Array of projection coordinates along the top of the scene.
LEFT_LOC	variable	= (NNNN, NNNN, NNNN, ...)	Array of tic mark locations along the left of the scene.
LEFT_TIC	variable	= (UNNN, VNNN, VNNN, ...)	Array of coordinate labels along the left of the scene.
LEFT_TICU	variable	= (XXXX.XXX, XXXX.XXX, XXXX.XXX, ...)	Array of projection coordinates along the left of the scene.
RIGHT_LOC	variable	= (NNNN, NNNN, NNNN, ...)	Array of tic mark locations along the right of the scene.
RIGHT_TIC	variable	= (UNNN, VNNN, VNNN, ...)	Array of coordinate labels along the right of the scene.
RIGHT_TICU	variable	= (XXXX.XXX, XXXX.XXX, XXXX.XXX, ...)	Array of projection coordinates along the right of the scene.
BOTTOM_LOC	variable	= (NNNN, NNNN, NNNN, ...)	Array of tic mark locations along the bottom of the scene.
BOTTOM_TIC	variable	= (VNNN, VNNN, VNNN, ...)	Array of coordinate labels along the bottom of the scene.
BOTTOM_TICV	variable	= (XXXX.XXX, XXXX.XXX, XXXX.XXX, ...)	Array of projection coordinates along the bottom of the scene.
END_GROUP		= TICS	End of the tics metadata group.
END_GROUP		= L0RP_ANNOTATION_FILE	End of the annotation metadata ODL group.
END			Required standalone parameter signifying the file end.

Table 4-18 Annotation File

4.3.8 Ancillary Data (TM-A Format)

The ancillary file contains grid information describing the geometric corrections applied, as well as general information about the state of the satellite (e.g., scene center ephemeris and attitude). This is an ASCII ODL file. Table 4-19 lists the contents of the ancillary data file.

Vdata Name: “LMXsssfnYYDOYHHuuvv.ANC”			
Vdata Class: Ancillary_Metadata			
Interlace Type: FULL_INTERLACE			
Number of Records: One record.			
Field Name: Ancillary			
Parameter Name	**Size (ASCII bytes)**	**Value, Format, Range, and Units**	**Parameter Description/Remarks**
GROUP		= L0RP_ANCILLARY_FILE	
GROUP		= GENERAL_INFO	
OUT_SCALE_INTER_PIXEL	variable	= NNNN.NNNN	Scale of inter-pixel distance in meters in an output image.
OUT_SCALE_INTER_LINE	variable	= NNNN.NNNN	Scale of inter-line distance in meters in an output image.
SEMIMAJOR_AXIS	Variable	= NNNN.NNNN	Semi-major axis of the Earth ellipsoid in meters.
SEMIMINOR_AXIS	variable	= NNNN.NNNN	Semi-minor axis of the Earth ellipsoid in meters.
SCENE_SEQUENCE_NUM			
WRS_PATH			
WRS_ROW			
MISSION			
FIRST_SCAN_TIME			
LAST_SCAN_TIME			
CENTER_TIME_TO_PCD			
NUM_SWEEPS	variable	= NNNN	Number of sweeps prior to scene center.
NUM_SCANS			
EARTH_RADIUS			
ORBIT_RADIUS			
EARTH_ROTATION	Variable	= NNNN.NNNN	Earth rotation velocity at nadir in meters per second.
SPACECRAFT_HEADING			
XSCAN_MATRIX_OFFSET			
PCD_TELEMETRY_START_TIME			
PCD_TELEMETRY_STOP_TIME			
WRS_CENTER_LAT	variable	= NNNN.NNNN	WRS frame center latitude in radians.
WRS_CENTER_LON	variable	= NNNN.NNNN	WRS frame center longitude in radians.
SCENE_CENTER_LAT	variable	= NNNN.NNNN	= NNNN.NNNN

Vdata Name: “LMXsssfnYYDOYHHuuvv.ANC”			
Vdata Class: Ancillary_Metadata			
Interlace Type: FULL_INTERLACE			
Number of Records: One record.			
Field Name: Ancillary			
Parameter Name	**Size (ASCII bytes)**	**Value, Format, Range, and Units**	**Parameter Description/Remarks**
SCENE_CENTER_LON	variable	= NNNN.NNNN	= NNNN.NNNN
MAP_PROJECTION_1			
SOM_ROW_SWITCH			
SOM_SCENE_CENTER_X			
SOM_SCENE_CENTER_Y			
SOM_DISPLAY_ROTATION			
HORIZONTAL_DISPLAY_SHIFT			
MAP_PROJECTION_2			
CENTRAL_MERIDIAN			
SCENE_CENTER_X		= NNNN.NNNN	Scene center in Earth-Centered, Earth-Fixed (ECEF) coordinates in meters – X.
SCENE_CENTER_Y		= NNNN.NNNN	Scene center in ECEF coordinates in meters – Y.
DISPLAY_ROTATION			
MATRICES_SEQ_NUM			
POS_VEC_SCANRATE			
END_GROUP		= GENERAL_INFO	
GROUP		=MIRROR_MODEL	
FORWARD_COEFS			
REVERSE_COEFS			
MIRROR_ANGLE_FH			
MIRROR_ANGLE_SH			
END_GROUP		=MIRROR_MODEL	
GROUP		= BENCHMARKS	
P0_SOM_FWD_ROW1			
P0_SOM_FWD_ROW2			
P0_SOM_FWD_ROW3			
P0_SOM_FWD_ROW4			
P0_SOM_REV_ROW1			
P0_SOM_REV_ROW2			
P0_SOM_REV_ROW3			
P0_SOM_REV_ROW4			

Vdata Name: “LMXsssfnYYDOYHHuuvv.ANC”			
Vdata Class: Ancillary_Metadata			
Interlace Type: FULL_INTERLACE			
Number of Records: One record.			
Field Name: Ancillary			
Parameter Name	**Size (ASCII bytes)**	**Value, Format, Range, and Units**	**Parameter Description/Remarks**
Y0_SOM_FWD_ROW1			
Y0_SOM_FWD_ROW2			
Y0_SOM_FWD_ROW3			
Y0_SOM_FWD_ROW4			
Y0_SOM_REV_ROW1			
Y0_SOM_REV_ROW2			
Y0_SOM_REV_ROW3			
Y0_SOM_REV_ROW4			
P1_SOM_FWD_ROW1			
P1_SOM_FWD_ROW2			
P1_SOM_FWD_ROW3			
P1_SOM_FWD_ROW4			
P1_SOM_REV_ROW1			
P1_SOM_REV_ROW2			
P1_SOM_REV_ROW3			
P1_SOM_REV_ROW4			
Y1_SOM_FWD_ROW1			
Y1_SOM_FWD_ROW2			
Y1_SOM_FWD_ROW3			
Y1_SOM_FWD_ROW4			
Y1_SOM_REV_ROW1			
Y1_SOM_REV_ROW2			
Y1_SOM_REV_ROW3			
Y1_SOM_REV_ROW4			
P0_FWD_ROW1			
P0_FWD_ROW2			
P0_FWD_ROW3			
P0_FWD_ROW4			
P0_REV_ROW1			
P0_REV_ROW2			
P0_REV_ROW3			
P0_REV_ROW4			
Y0_FWD_ROW1			
Y0_FWD_ROW2			
Y0_FWD_ROW3			
Y0_FWD_ROW4			
Y0_REV_ROW1			

Vdata Name: “LMXsssfnYYDOYHHuuvv.ANC”			
Vdata Class: Ancillary_Metadata			
Interlace Type: FULL_INTERLACE			
Number of Records: One record.			
Field Name: Ancillary			
Parameter Name	**Size (ASCII bytes)**	**Value, Format, Range, and Units**	**Parameter Description/Remarks**
Y0_REV_ROW2			
Y0_REV_ROW3			
Y0_REV_ROW4			
P1_FWD_ROW1			
P1_FWD_ROW2			
P1_FWD_ROW3			
P1_FWD_ROW4			
P1_REV_ROW1			
P1_REV_ROW2			
P1_REV_ROW3			
P1_REV_ROW4			
Y1_FWD_ROW1			
Y1_FWD_ROW2			
Y1_FWD_ROW3			
Y1_FWD_ROW4			
Y1_REV_ROW1			
Y1_REV_ROW2			
Y1_REV_ROW3			
Y1_REV_ROW4			
END_GROUP		= BENCHMARKS	
GROUP		= DETECTOR_INFO	
NOMINAL_ALONG_LOC			
ALONG_LOC			
NOMINAL_ACROSS_LOC			
NOMINAL_ACROSS_DET_SPACING			
ODD_SHIFT			
END_GROUP		= DETECTOR_INFO	
GROUP		= SCAN_INFO	
SEQ_NUM			
REC_NUM			
LINE_LENGTH			
TIME_TO_PCD			
ALONG_MATRIX(X) – (XXX)			Entry for each of the 374 scans.
ACROSS_MATRIX(X) – (XXX)			Entry for each of the 374 scans.

Vdata Name: “LMXsssfnYYDOYHHuuvv.ANC”			
Vdata Class: Ancillary_Metadata			
Interlace Type: FULL_INTERLACE			
Number of Records: One record.			
Field Name: Ancillary			
Parameter Name	**Size (ASCII bytes)**	**Value, Format, Range, and Units**	**Parameter Description/Remarks**
END_GROUP		= SCAN_INFO	
END_GROUP		= L0RP_ANCILLARY_FILE	
END			

Table 4-19. Ancillary Data File

4.3.9 Vgroup Definitions

The Vgroup structure was designed to associate related HDF data objects. Any HDF data object (e.g., Vdata, SDSs, attributes) can be included in an HDF Vgroup definition. Vgroups employ Vgroup names and Vgroup classes for characterizing a collection of data objects and for searching purposes. Five classes are recognized for L0Rp data: image data, calibration data, correction data, parameter data, and metadata.

The HDF Vgroup interface consists of routines for accessing and acquiring information about the L0Rp data Vgroups. This information is stored in the HDF data directory.

Table 4-20 presents the Vgroups used to relate the different component or data objects that make up a complete L0Rp data set.

Vgroup Name	Vgroup Class	Data Object Contents		HDF Tag	Description
		Object Name	Type		
Scene_Data_30m	Image_Data	“LMXsss1nYYDOYHHuuvv.B10”	SDS	DFTAG_NDG	TM Band 1 30m data
		“LMXsss1nYYDOYHHuuvv.B20”	SDS	DFTAG_NDG	TM Band 2 30m data
		“LMXsss1nYYDOYHHuuvv.B30”	SDS	DFTAG_NDG	TM Band 3 30m data
		“LMXsss1nYYDOYHHuuvv.B40”	SDS	DFTAG_NDG	TM Band 4 30m data
		“LMXsss1nYYDOYHHuuvv.B50”	SDS	DFTAG_NDG	TM Band 5 30m data
		“LMXsss1nYYDOYHHuuvv.B70”	SDS	DFTAG_NDG	TM Band 7 30m data
		“LMXsss1nYYDOYHHuuvv.GEO”	Vdata	DFTAG_VH	Geolocation table
Scene_Data_120m	Image_Data	“LMXsss1nYYDOYHHuuvv.B60”	SDS	DFTAG_NDG	TM Band 6 120m
		“LMXsss1nYYDOYHHuuvv.GEO”	Vdata	DFTAG_VH	Geolocation table
IC_Data_30m	Calibration_ Data	“LMXsss1nYYDOYHHuuvv.C10”	SDS	DFTAG_NDG	IC data Band 1 30m
		“LMXsss1nYYDOYHHuuvv.C20”	SDS	DFTAG_NDG	IC data Band 2 30m
		“LMXsss1nYYDOYHHuuvv.C30”	SDS	DFTAG_NDG	IC data Band 3 30m
		“LMXsss1nYYDOYHHuuvv.C40”	SDS	DFTAG_NDG	IC data Band 4 30m
		“LMXsss1nYYDOYHHuuvv.C50”	SDS	DFTAG_NDG	IC data Band 5 30m
		“LMXsss2nYYDOYHHuuvv.C70”	SDS	DFTAG_NDG	IC data Band 7 30m
		“LMXsss1nYYDOYHHuuvv.GEO”	Vdata	DFTAG_VH	Geolocation table
IC_Data_120m	Calibration_ Data	“LMXsss1nYYDOYHHuuvv.C60”	SDS	DFTAG_NDG	IC data Band 6 120m
		“LMXsss1nYYDOYHHuuvv.GEO”	Vdata	DFTAG_VH	Geolocation table
Scan_Line_Offsets_30m	Correction_ Data	“LMXsss1nYYDOYHHuuvv.O10”	Vdata	DFTAG_VH	Scan line offsets Band 1
		“LMXsss1nYYDOYHHuuvv.O20”	Vdata	DFTAG_VH	Scan line offsets Band 2
		“LMXsss1nYYDOYHHuuvv.O30”	Vdata	DFTAG_VH	Scan line offsets Band 3
		“LMXsss1nYYDOYHHuuvv.O40”	Vdata	DFTAG_VH	Scan line offsets Band 4

		“LMXsss1nYYDOYHHuuvv.O50”	Vdata	DFTAG_VH	Scan line offsets Band 5
		“LMXsss2nYYDOYHHuuvv.O70”	Vdata	DFTAG_VH	Scan line offsets Band 7
		“LMXsss2nYYDOYHHuuvv.GEO”	Vdata	DFTAG_VH	Geolocation table
Scan_Line_Offsets_120m	Correction_Data	“LMXsss1nYYDOYHHuuvv.O60”	Vdata	DFTAG_VH	Scan line offsets Band 6
		“LMXsss1nYYDOYHHuuvv.GEO”	Vdata	DFTAG_VH	Geolocation table
PCD	Correction_Data	“LMXsss1nYYDOYHHuuvv.PCD”	Vdata	DFTAG_VH	PCD
MSCD	Correction_Data	“LMXsss1nYYDOYHHuuvv.MSD”	Vdata	DFTAG_VH	MSCD
Product_Metadata	Metadata	“LMXsss1nYYDOYHHuuvv.MTA”	Vdata	DFTAG_VH	Metadata
		“LMXsss1nYYDOYHHuuvv.MTP”	Vdata	DFTAG_VH	Metadata—product specific
CPF	Parameter_Data	“LMCPFYYYYMMDD_YYYYMMDD.nn”	Vdata	DFTAG_VH	IAS calibration parameter file

Table 4-20. Vgroup Definition for the Landsat TM L0Rp Data

Section 5 Product Packaging

Files are delivered to the Level 1 System according to the LSDS-825 Subsetter System Interface Specification Document (ISD) (see References).

Data are written using the Tape Archive (TAR) utility format (per IEEE Portable Operating System Interface for Unix (POSIX) standard 1003.1), thus preserving directory structure and file names. The no-swap device and a fixed blocking factor of 256-512-byte blocks maximize portability between platforms. The LPGS creates a tarball of all product files and then GZips (compresses) the product.

Section 6 Software Tools

A variety of public domain software tools are available for processing the L0Rp data in an HDF-EOS, HDF, or independent computing environment.

6.1 NCSA HDF Libraries

HDF is a library- and platform-independent data format for the storage and exchange of scientific data. It includes Fortran and C calling interfaces and is used for analyzing and converting HDF data files. NCSA developed and supported HDF; HDF is available in the public domain.

The HDF library contains two parts: the base library and the multi-file library. The base library contains a general-purpose interface and application-level interfaces, one for each data structure type. Each application-level interface is specifically designed to read, write, and manipulate one type. The general-purpose interface contains functions, such as file Input / Output (I/O), error handling, memory management, and physical storage. HDF library functions can be called from C or Fortran user application programs.

HDF source code for UNIX, Virtual Memory Storage (VMS), Windows NT/95, and Macintosh is available via anonymous File Transfer Protocol (FTP) from http://hdf.ncsa.uiuc.edu/obtain.html. HDF reference manuals, user guides, release notes, and newsletters are web accessible at http://hdf.ncsa.uiuc.edu.

6.2 HDF-EOS Libraries

HDF-EOS is standard HDF with metadata added. The principal distinction is the specification of three geolocation data types: point, grid, and swath, which allow the file contents to be queried by Earth coordinates and time using the HDF-EOS Application Programming Interface (API). The Landsat 4 and Landsat 5 L0Rp data do not employ either of these data structures. However, any application that makes use of the HDF-EOS API, as a consequence of linking to the API, have access to the NCSA native base libraries that can be used to access the L0Rp data.

EOSView is a file-viewing tool developed to examine and verify HDF and HDF-EOS data files. This tool enables users of EOS data products to view the contents of HDF files and individual objects via straightforward product access and display tools. Supported record types for viewing and displaying capabilities include images, multidimensional arrays, text, Vdata, and Vgroups. EOSView users see the underlying HDF structures and are prompted for parts of the structure to view.

Users of the Landsat 4 and Landsat 5 L0Rp data may also find the Science Data Production (SDP) Toolkit useful for follow-on processing. The SDP Toolkit consists of a set of fully tested and reliable C and Fortran language functions, customized for application to product generation software. Of particular interest to Landsat TM data users is the ODL parser, which allows reading, writing, and manipulating product metadata and the Digital Elevation Model (DEM) software tools.

The SDP Toolkit and HDF-EOS libraries are available at http://newsroom.gsfc.nasa.gov/sdptoolkit/toolkit.html. Because this software was developed under a NASA contract and is intended for EOS instrument teams and science investigators, access to download the software is password protected. Send an e-mail to landover_PGSTLKIT@raytheon.com to obtain the password.

6.3 ODL Parser

The ODL parser (Version 1.0) incorporated into the SDP Toolkit was originally implemented by the University of Colorado's Laboratory for Atmospheric and Space Physics (LASP). The JPL enhanced the ODL parser in building their Planetary Data System. The improved ODL software (Version 2.1), which is maintained by LASP, is available at the following website address: http://caster.gsfc.nasa.gov/IAS/COTS/ias_cots.html.

Version 2.1 or later should be particularly useful to those operating in a non-HDF-EOS environment. The software stands alone and can be used to read the L0Rp metadata external elements and the CPF.

Section 7 HDF Tools

7.1 HDF Data Directory Listing

A variety of tools exist for examining the contents of an L0Rp data set. For example, the NCSA-developed hdp utility provides quick and general information about all objects in the specified HDF file. It lists the contents of HDF files at various levels with different details and can dump the data of one or more specific objects in the file. See the References section for HDF usage details.

A second tool is the EOSView file-viewing tool, which was developed to examine and verify HDF and HDF-EOS data files. This tool enables the EOS data product user to view the contents of HDF files and individual objects by reading and displaying all metadata fields and data objects. All data objects present in the L0Rp data are supported. EOSView users see the underlying HDF structures and are prompted for the parts of the structure to view. For additional details, refer to the HDF documents in the References section.

References

See https://landsat.usgs.gov/glossary-and-acronyms for a list of acronyms.

HDF User's Guide. Version 4.2.7. March 2012. http://www.hdfgroup.org/doc.html

HDF Specification and Developer's Guide. Version 4.2.3. June 2008. http://www.hdfgroup.org/doc.html

HDF Reference Manual. Release 4.2.7. March 2012. http://www.hdfgroup.org/doc.html

IEEE Standard 1003.1-2008 - IEEE Standard for Information Technology - Portable Operating System Interface (POSIX(R)). 2008

JPL D-7669, Part 2, Planetary Data System Standards Reference, "Object Description Language Specification and Usage, March 20, 2006, Version 3.7

USGS/EROS. LSDS-43. Landsat 4-5 Thematic Mapper (TM) Calibration Parameter File (CPF) Definition.

USGS/EROS. LSDS-273. Landsat 2-5 Thematic Mapper (TM) and Multispectral Scanner (MSS) Level 0 (L0) Data Format Control Book (DFCB).

USGS/EROS. LSDS-547. Landsat Ground Station (GS) Identifiers.