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Department of the Interior
U.S. Geological Survey

LANDSAT 7 (L7)
ENHANCED THEMATIC MAPPER PLUS (ETM+)
LEVEL 1 (L1)
DATA FORMAT CONTROL BOOK (DFCB)

Version 19.0

August 2016

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Approved By:

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Executive Summary

This Data Format Control Book (DFCB) presents detailed data formats of the output files that the Image Assessment System (IAS) and Level 1 Product Generation System (LPGS) generate. These Level 1 (L1) processing systems produce L1 output files from Level 0 Reformatted (L0R) images based on user requests. Images are produced in the Geographic Tagged Image File Format (GeoTIFF) format.

The Landsat Operations and Sustaining (O&S) Configuration Control Board (CCB) maintains and controls this DFCB. Staff may update or revise this document only upon Landsat O&S CCB approval. Please direct comments and questions regarding this DFCB to the following:

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Section 1 Introduction

1.1 Purpose

This Data Format Control Book (DFCB) provides a high-level description of the Landsat 7 Level 1 (L1) distribution product, product packaging, and viewing tools.

1.2 Scope

This DFCB describes the formats and data contents of the L1 output files. The output format generated by the Level 1 Product Generation System (LPGS) for distribution is Geographic Tagged Image File Format (GeoTIFF).

The file formats contained in this DFCB are applicable to the products generated by L1 producing systems operated at the U.S. Geological Survey (USGS) Earth Resources Observation and Science (EROS) Center.

1.3 Intended Users

This document is a guide for L1 product recipients. It provides detailed information on L1 product packaging.

1.4 Definitions

Level 0 Reformatted Product (L0Rp) digital image — Spatially reformatted, demultiplexed, and unrectified subinterval data

L0Rp product — L0Rp digital image plus radiometric, calibration, spacecraft attitude, and ephemeris data, consisting of the following files in Hierarchical Data Format (HDF):

- L0Rp digital image (one file per band)
- Internal Calibrator (IC) data — Calibration data file containing all of the calibration data received on a major frame basis subset to the product size ordered
- Mirror Scan Correction Data (MSCD) — Scan direction and error information subset to the product size ordered
- Payload Correction Data (PCD) — Information on spacecraft attitude and ephemeris, including quality indicators for the entire subinterval from which the product is derived
- Metadata — Descriptive information about the L0Rp image and names of appended files associated with the image
- Calibration Parameter File (CPF) — Formatted file containing radiometric and geometric correction parameters
- Scan Line Offsets (SLO) — Information on actual starting and ending pixel positions for valid image data on a line-by-line basis
- Geolocation table — File containing scene corner coordinates and product-specific scene line numbers for bands
- HDF directory — File containing all of the pointers, file size information, and data objects required to process the L0Rp product

Level 1 Radiometric (Corrected) (L1R) digital image — Radiometrically corrected but not geometrically resampled

Consensus File — A single file created from the two original files included with the L0Rp product, with errors corrected

Level 1 Geometrically Corrected (L1GS) digital image — Radiometrically corrected and resampled for geometric correction and registration to a geographic map projection

L1GS product — L1 product distributed by the LPGS that includes, for all requested bands, GeoTIFF format L1GS images and associated data accommodated by the format

L1GS gap-filled product — L1GS gap-filled product that includes radiometric and geometric corrections and Scan Line Corrector-off (SLC-off) induced missing pixels filled with mathematically calculated values based on co-registered data. (The product includes a gap mask for each band that identifies the source of the fill data on a pixel-by-pixel basis.)

Level 1 Systematic Terrain (Corrected) (L1GT) product — L1GT Terrain Correction product that includes radiometric and geometric corrections, and uses a Digital Elevation Model (DEM) to correct parallax error due to local topographic relief; the accuracy of the terrain-corrected product depends on the resolution of the best available DEM

Level 1 Terrain (Corrected) (L1TP) product — Includes radiometric, geometric, and precision correction, and uses a DEM to correct parallax errors due to local topographic relief; the accuracy of the terrain-corrected product depends on the availability of Ground Control Points (GCPs), as well as the resolution of the best available DEM

Gap Mask — The Gap Mask Files that accompany a Landsat 7 Enhanced Thematic Mapper Plus (ETM+) SLC-off or gap-filled product are bit mask files that show the locations of the image gaps (areas that fall between ETM+ scans) for SLC-off imagery and provide the fill source data for gap-filled imagery. SLC-off and gap-filled products have one Gap Mask File per band, while segment-based gap-filled products have only three Gap Mask Files for the pan, reflective, and thermal bands, respectively.

Interval — Time duration between the start and stop of an imaging operation (observation) of the Landsat 7 ETM+ instrument

Subinterval — Segment of time corresponding to a portion of an observation within a single Landsat 7 contact period

Worldwide Reference System (WRS) scene — Digital image that covers an area equivalent to one of the 57,784 scene centers (233 paths by 248 rows areas) defined by the WRS structure

1.5 Level 0 (L0) Pre-Archive Processing

A basic knowledge of pre-archive ground processing enables the user to better understand the L1 product.

The Landsat Ground System (LGS) acquires ETM+ wideband data directly from the Landsat 7 spacecraft by way of two 150 megabits-per-second (Mbps) X-Band return links. Each X-Band data link is separated into two 75 Mbps channels (In-Phase Channel [I] and Quadrature Channel [Q]) and transmits the acquired wideband data over four 75 Mbps LGS output channels to the Landsat Processing System (LPS). The LPS records all wideband data, at real-time rates, into its wideband data stores. An I-Q channel pair represents a complete data set. One channel holds Bands 1 through 6 low-gain, and the second channel holds Bands 7 and 8 and a high-gain form of Band 6.

The LPS retrieves and processes each channel of raw wideband data, at lower than real-time rates, into separate accumulations of Earth image data, calibration data, MSCD, and PCD. Channel accumulations represented by Band 1 through Band 6-low and Band 6-high through Band 8 become Formats 1 and 2, respectively. PCD and MSCD are generated twice, once for each format. Their contents should be identical, but they are not guaranteed to be identical.

The LPS spatially reformats Earth imagery and calibration data into Level Zero Reformatted Archive (L0Ra) data. This involves shifting pixels by integer amounts to account for the alternating forward-reverse scanning pattern of the ETM+ sensor, the odd-even detector arrangement within each band, and the detector offsets inherent in the focal plane array engineering design. All LPS Zero Reformatted (0R) corrections are reversible; the Image Assessment System (IAS) CPF documents the pixel shift parameters used.

During LPS processing, Format 1 bands are duplicated, aligned, and used to assess cloud cover content and generate scene-based browse data. Cloud cover scores are generated on a scene-by-scene and quadrant-by-quadrant basis. Metadata are generated for the entire subinterval and on a scene-by-scene basis. The image data, PCD, MSCD, calibration data, and metadata are structured into HDF for each format and sent to EROS for archiving in subinterval form. The two formats of data are united when a Landsat 7 Level 0 Reformatted (L0R) product is ordered. The browse files are sent to EROS search and order systems separately for use as an online aid to ordering.

Section 2 Overview of Level 1 Output Files

This section provides an overview of the L1 output files.

2.1 L1GS / L1GT / L1TP Output Files Overview

The L1R digital image is very similar to the L0Rp digital image, except that the L1R image data are radiometrically corrected. In addition, the Format 1 and Format 2 PCD files are combined into one consensus file, as are the Format 1 and Format 2 MSCD files.

The consensus file is a single file created from the two original files included with the L0Rp product, with errors corrected. The L1GS digital image is radiometrically and geometrically corrected and is available in GeoTIFF format. The L1TP includes radiometric, geometric, and precision correction, and uses a DEM to correct parallax error due to local topographic relief. The L1GT product is radiometrically and geometrically corrected and uses DEM to correct parallel error due to local topographic relief.

The on-demand L1 products available for download at no charge are generated using a standard set of parameters. These are the only processing parameters available for the L1 output products through the external ordering interface(s). These products are output using the best available processing level for that particular scene (L1TP, L1GT, or L1GS). The processing parameters and output product details used for all standard products are as follows:

- Pixel Size — 15 meter (m) (Panchromatic band) / 30 m (Thermal and Reflective bands)
- Output Format — GeoTIFF
- Resampling Method — Cubic Convolution (CC)
- Map Projection — Universal Transverse Mercator (UTM) Polar Stereographic (PS) for Antarctica scenes
- Datum — World Geodetic System 1984 (WGS84)
- Image Orientation — Map (North Up (NUP))
- Distribution — Hypertext Transfer Protocol (HTTP) download

Note: The Landsat 7 ETM+ SLC-off segment-based gap-filled product options are more limited than other Landsat 7 products primarily due to the need to match the GLS2000 data set for generating GCPs and segment maps. Specific requirements include the following:

- Pixel Size — 15 m (Panchromatic band) / 30 m (Thermal and Reflective bands)
- Product type: — L1TP only (need to match GLS)
- Map projection: — UTM only (need to match GLS) No +/– 1 zone option
- Orientation: — North Up (NUP) only (need to match GLS)

Quality Band (QB) file	X	X	X
Angle Coefficient File	X	X	X

Table 2-1 details the L1 product components included with each format.

Component	L1GS	L1GT	L1TP
L1 image file (for each requested band)	X	X	X
L1 Metadata file (text [.txt] file)	X	X	X
GCP file (text [.txt] file)			X
Gap Mask (.tif.gz file)	SLC-off & gap-filled	SLC-off & gap-filled	SLC-off & gap-filled
Quality Band (QB) file	X	X	X
Angle Coefficient File	X	X	X

Table 2-1. GeoTIFF Product Components

2.2 Gap Mask (SLC-off Products Only) Overview

The Gap Mask File is created during product generation and contains the location of all pixels affected by the original SLC-off scene gaps, prior to any interpolation gap-filling. The gap masks are 8-bit images that have dimensions identical to the corresponding image band files to simplify data access and viewing. The gap mask uses code 0 to represent no data, and codes 1 through 6 to identify the source image for each filled pixel. Code 1 refers to the primary scene and codes 2 through 6 refer to fill scenes used in the gap-fill product, as indicated in the MTL file.

2.3 Naming Convention

The file-naming convention for the GeoTIFF product is as follows:

<LANDSAT_PRODUCT_ID>_BN.XXX, where LANDSAT_PRODUCT_ID is LXSS_LLLL_PPPRRR_YYYYMMDD_yyyymmdd_CC_QQ, where

L	=	Landsat
X	-	Sensor: E = ETM+
SS	=	Satellite: 07 = Landsat 7
LLLL	=	Processing Level (L1TP, L1GT, L1GS)
PPP	=	Three-digit WRS path
RRR	=	Three-digit WRS row
YYYYMMDD	=	Acquisition Year (YYYY) / Month (MM) / Day (DD)
yyyymmdd	=	Processing Year (yyyy) / Month (mm) / Day (dd)
CC	=	Collection Number
QQ	=	Collection Category: RT = Real-Time T1 = Tier 1 (stackable) T2 = Tier 2 (non-stackable)
BN		Product Component: B1 = Band 1 B2 = Band 2 B3 = Band 3 B4 = Band 4 B5 = Band 5 B6_VCID_1 = Band 6 Visual Channel Identifier (VCID) 1 B6_VCID_2 = Band 6 VCID 2 B7 = Band 7 B8 = Band 8 BQA = Quality Band GCP = GCP File MTL = Metadata File ANG = Angle Coefficient File
XXX		File type: = TIF file extension for all image data = .txt file extension for GCP and MTL Files

Table 2-2. GeoTIFF Product Naming Convention

The file-naming convention for the Gap Mask Files is as follows:

<LANDSAT_PRODUCT_ID> _GM_BN.XXX, where LANDSAT_PRODUCT_ID is LXSS_LLLL_PPPRRR_YYYYMMDD_yyyymmdd_CC_QQ, where

L	=	Landsat
X	=	Sensor: E = ETM+
SS	=	Satellite: 07 = Landsat 7
LLLL	=	Processing Level (L1TP, L1GT, L1GS)
PPP	=	Three-digit WRS path
RRR	=	Three-digit WRS row
YYYYMMDD	=	Acquisition Year (YYYY) / Month (MM) / Day (DD)
yyyymmdd	=	Processing Year (yyyy) / Month (mm) / Day (dd)
CC	=	Collection Number
QQ	=	Collection Category: RT = Real-Time T1 = Tier 1 (stackable) T2 = Tier 2 (non-stackable)
GM	=	Gap Mask
BN	=	Product Component: B1 = Band 1 B2 = Band 2 B3 = Band 3 B4 = Band 4 B5 = Band 5 B6_VCID_1 = Band 6 VCID 1 B6_VCID_2 = Band 6 VCID 2 B7 = Band 7 B8 = Band 8
XXX	=	File type: = TIF file extension for all image data

Table 2-3. Gap Mask File-Naming Convention

Section 3 L1 Output File Formats

This section describes the storage format for the data.

3.1 GeoTIFF File Formats

GeoTIFF defines a set of public domain Tagged Image File Format (TIFF) tags that describe all cartographic and geodetic information associated with GeoTIFF imagery. GeoTIFF is a means for tying a raster image to a known model space or map projection and for describing those projections. A metadata format provides geographic information to associate with the image data, but the TIFF file structure allows both the metadata and the image data to be encoded into the same file.

3.1.1 L1 Image File and Gap Mask File

The description of an image in GeoTIFF requires tags and keys, as described in the GeoTIFF Specification document (see References). These tags and keys are included in the L1 image files and are automatically detected and read by TIFF readers. The following subsections describe the tags and keys.

Each Earth image band in the requested product is contained in a separate file. The data are laid out in a scan-line sequential format in descending detector order (i.e., detector 16 followed by detector 15 and so forth for the 30 m bands). The L1R image is radiometrically corrected, but is not geometrically resampled. The L1GS image is radiometrically corrected and resampled for geometric correction and registration to geographic map projections. The L1TP image is radiometrically, geometrically, and precision corrected, and uses a DEM to correct parallax error due to local topographic relief.

Each image band in the L1 product is in a separate file. Each band comprises a grayscale, scan line, GeoTIFF file; this file is in uncompressed 8-bit unsigned integers.

3.1.1.1 GeoTIFF Tags

TIFF tags convey metadata information about the image. The tags describe the image using information the TIFF reader needs to control the appearance of the image on the user's screen. The TIFF tags are in the same file as the TIFF image.

A complete description of the raster data requires georeferencing of the data, which uses tags. Landsat 7 L1 production systems use the transformation raster and model space tie points and scaling parameters. ModelTiepointTag and ModelPixelScaleTag are used for this purpose.

ModelTiepointTag
Tag = 33922
Type = DOUBLE
N = 6*K, K = number of tiepoints
Alias: GeoreferenceTag
Owner: Intergraph

The ModelTiepointTag stores the raster-to-model tiepoint pairs in the following order:

ModelTiepointTag = (..., I, J, K, X, Y, Z...)

where (I, J, K) is the point at location (I, J) in raster space with pixel-value K, and (X, Y, Z) is a vector in model space.

The raster image is georeferenced by specifying its location, size, and orientation in the model coordinate space. Because the relationship between the raster space and the model space is often an exact, affine transformation, the relationship can be defined using one set of tiepoints and the ModelPixelScaleTag, which gives the vertical and horizontal raster grid cell size.

ModelPixelScaleTag
Tag = 33550
Type = DOUBLE
N = 3
Owner: SoftDesk

The ModelPixelScaleTag specifies the size of raster pixel spacing in the model space units when the raster space can be embedded in the model space coordinate system without rotation, and consists of the following three values:

ModelPixelScaleTag = (ScaleX, ScaleY, ScaleZ)

where ScaleX and ScaleY give the horizontal and vertical spacing of raster pixels, and ScaleZ maps the pixel value of a DEM into the correct Z-scale. ScaleZ is not used for L1GS data because it is only systematically corrected and not corrected for elevation.

A single tiepoint in the ModelTiepointTag, together with the ModelPixelScaleTag, completely determines the relationship between raster and model space.

3.1.1.2 GeoTIFF Keys

In addition to tags, the description of a projection in GeoTIFF requires using keys. Table ***3-1*** lists the keys necessary to define the projections supported by the L1 production systems and the possible values of the keys.

Valid Keys	Possible Values	Meaning
Universal TM (UTM)		
GTModelTypeGeoKey	1	ModelTypeProjected (Projection Coordinate System)
GTRasterTypeGeoKey	1	RasterPixelIsArea
	2	RasterPixelIsPoint
GTCitationGeoKey	(ASCII, 17)	American Standard Code for Information Interchange (ASCII) reference to public documentation
GeogLinearUnitsGeoKey	9001	Linear_Meter
	9002	Linear_Foot
GeogAngularUnitsGeoKey	9102	Angular_Degree
ProjectedCSTypeGeoKey	20000–32760	European Petroleum Survey Group (EPSG) Projection System Codes
	32767	User-defined
Polar Stereographic (PS)		
ProjCoordTransGeoKey	15	CT_PolarStereographic
GTModelTypeGeoKey	1	ModelTypeProjected (Projection Coordinate System)
GTRasterTypeGeoKey	1	RasterPixelIsArea
	2	RasterPixelIsPoint
GTCitationGeoKey	(ASCII, 17)	ASCII reference to public documentation
GeographicTypeGeoKey	4326	GCS_WGS_84
GeogLinearUnitsGeoKey	9001	Linear_Meter
	9002	Linear_Foot
GeogAngularUnitsGeoKey	9102	Angular_Degree
ProjectedCSTypeGeoKey	20000–32760	EPSG Projection System Codes
	32767	User-defined
ProjectionGeoKey	10000–19999	EPSG / Petrotechnical Open Software Corporation (POSC) Projection Codes
	32767	User-defined
ProjLinearUnitsGeoKey	9001	Linear_Meter
	9002	Linear_Foot
ProjStraightVertPoleLongGeoKey		Value in units of GeogAngularUnits
ProjNatOriginLatGeoKey		Value in units of GeogAngularUnits
ProjFalseNorthingGeoKey		Value entered in units of ProjLinearUnits
ProjFalseEastingGeoKey		Value entered in units of ProjLinearUnits

Table* 3-1*. GeoTIFF Keys

3.1.2 Quality Band (QB) File

The QB file contains quality statistics gathered from the image data and cloud mask information for the scene. The QB file is an unsigned 16-bit image with the same dimensions as the L1 scene. Bit 0 is the least significant. Bits are allocated for data artifacts and several land surface classification types. A range of confidence levels are provided for each classification type.

The bit confidence levels are as follows:

00 No confidence level set (used for fill or for a class not reported)
01 Low confidence

10 Mid confidence
11 High confidence
0 Criteria not likely to exist, or not checked
1 Criteria likely to exist

Bit	Flag Description	Values
0	Designated Fill	0 or 1 Not checked
1	Dropped Pixel	0 Not likely to exist 1 Likely to exist
2-3	Radiometric Saturation	00 No bands saturated 01 1 to 2 bands saturated 10 3 to 4 bands saturated 11 Greater than 4 bands saturated
4	Cloud	0 Not likely to exist 1 Likely to exist
5-6	Cloud Confidence	00 Not checked 01 Low confidence 10 Mid confidence 11 High confidence
7-8	Cloud Shadow	00 Not checked 01 Low confidence 10 Mid confidence 11 High confidence
9-10	Snow/Ice	00 Not checked 01 Low confidence 10 Mid confidence 11 High confidence
11-15		Unused

Table 3-2. QBBit Description

3.1.3 L1 Metadata File

The L1 Metadata File is created during product generation and contains information specific to the product ordered. Table ***3-2*** lists the full contents of the L1 Metadata File. The L1 Metadata File complies with LSDS-524 Landsat Metadata Description Document (LMDD) (see References).

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description / Remarks
GROUP	18	= L1_METADATA_FILE	Beginning of the first-level Object Description Language (ODL) group; it indicates the start of the L1 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 from the USGS.

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description / Remarks
REQUEST_ID	20	USGS products use the "NNNYYMMDDSSSS_UUUUU" format, where: NNNYYMMDDSSSS = 13-digit TRAM order number NNN = Node indicator YY = Year MM = Month DD = Day SSSS = Sequence number for the day UUUUU = Five-digit Tracking, Recording, and Metrics (TRAM) unit number	Data producer-defined request number that uniquely identifies each product. USGS products use a unique product generation TRAM-generated request ID.
LANDSAT_SCENE_ID	21	= "LMSFPPPRRRYYYYDDDGSIVV" Where: L = Landsat M = Mission (E = ETM+)) S = Satellite (7) F = Format (1 or 2) PPP = WRS Path RRR = WRS Row YYYY = Year of Acquisition DDD = Day of Acquisition Year GSI = Ground Station Identifier VV = Version	Unique Landsat scene identifier. (Earth-imaging), orbital Path / Row.
LANDSAT_PRODUCT_ID	40	= "LXSS_LLLL_PPPRRR_YYYYMMDD_yyyymmdd_CC_QQ" Where: L = Landsat X = Sensor SS = Satellite LLLL = Processing level PPP = WRS path RRR = WRS row YYYYMMDD = Acquisition year / month / day yyyymmdd = Processing year / month / day CC = Collection number QQ = Collection Category	Unique Landsat product identifier. (Earth-imaging), orbital Path / Row.
COLLECTION_NUMBER	2	= 0 to 99	Unique two digit identifier to denote the Collection Number.

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description / Remarks
FILE_DATE	20	MTL ODL ASCII Time Format: = YYYY-MM-DDTHH:MI:SSZ Where: YYYY = Four-digit year MM = Month DD = Day T = Constant (indicates the start of time information in the ODL ASCII time code format) HH = Hour (00-23) MI = Minute SS = Seconds Z = Constant (indicates "Zulu" time (same as Greenwich Mean Time (GMT))	L1 system date and time when the Metadata File for the L1 product set was created.
STATION_ID	3	= “NNN”	Unique three-letter code identifying the originating Ground Station.
PROCESSING_SOFTWARE_VERSION	20	= “SYSTEM_VERSION” Where: SYSTEM =LPGS	Software name followed by version number(s) and separated by underscores. Example: LPGS_8.2.3
DATA_CATEGORY	11	= “NOMINAL” = “VALIDATION” = “EXCHANGE” = “TEST” = “ENGINEERING”	Current data category assigned to the data. Values: NOMINAL = Nominal data that exist within expected, acceptable limits. VALIDATION = Validation data obtained from an IGS in order to validate that the IGS data are of equivalent quality to those that the USGS maintains. EXCHANGE = Exchange data (between an IGS and the USGS) that require a quarantine period and have been successfully validated to be of equivalent quality to the corresponding USGS data. TEST = Test data. ENGINEERING = Engineering data that typically results from an inclination change to the spacecraft or Delta I Maneuver. Refer to LSDS-293 Landsat Data Management Policy.

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description / Remarks
END_GROUP	18	= METADATA_FILE_INFO	End of the metadata information group.
GROUP	16	= PRODUCT_METADATA	Beginning of the product metadata group.
DATA_TYPE	20	= “L1GS“ = “L1GT“ = “L1TP“	Identifier to inform the user of the data type.
ELEVATION_SOURCE	7	= “NED” = “RAMP” = “SRTM1” = “SRTM3” = “GTOPO30” = “GLS2000”	Identifies the digital elevation data set used to terrain correct the product. **Included for L1GS and L1TP products.
OUTPUT_FORMAT	10	= “GEOTIFF”	The output format.
EPHEMERIS_TYPE	10	= “DEFINITIVE” = “PREDICTIVE”	Identifier to inform the user of the orbital ephemeris type used. If the field is not present, the user should assume PREDICTIVE in all cases.
SPACECRAFT_ID	8	= “LANDSAT_7”	Name of the satellite platform.
SENSOR_ID	4	= “ETM”	Name of the imaging sensor.
SENSOR_MODE	6	= “SAM” = “BUMPER”	Scan Angle Monitor (SAM) Mode and Bumper (BUMPER) Mode.
WRS_PATH	3	= NNN, where NNN = the path number (001-251)	WRS-defined nominal Landsat satellite track (path). (orbital)
WRS_ROW	3	= NNN, where NNN = the row of the first full or partial scene in the product (001-248)	WRS-defined nominal Landsat satellite row, based on the latitudinal center frame of a Landsat image. (orbital)
DATE_ACQUIRED	10	MTL ODL ASCII Time Format: = YYYY-MM-DD Where: YYYY = Four-digit year MM = Month DD = Day	Year, month, day of month.
SCENE_CENTER_TIME	14	= “HH:MI:SS.SSSSSSSZ” Where: HH = Hour (00-23) MI = Minutes SS.SSSSSSS = Fractional seconds Z = Constant (indicates "Zulu" time (same as GMT))	Scene center time of the date the image was acquired.

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description / Remarks
CORNER_UL_LAT_PRODUCT	7	= -90.00000 through +90.00000 degrees. Positive (+) value indicates north latitude; negative (-) value indicates south latitude.	Latitude value for the upper-left corner of the product (the L1 systems recalculate for the geometrically-corrected product).
CORNER_UL_LON_PRODUCT	8	= -180.00000 through +180.00000 degrees. Positive (+) value indicates east longitude; negative (-) value indicates west longitude	Longitude value for the upper-left corner of the product (the L1 systems recalculate for the geometrically-corrected product).
CORNER_UR_LAT_PRODUCT	7	= -90.00000 through +90.00000 degrees.	Latitude value for the upper-right corner of the product (the L1 systems recalculate for the geometrically-corrected product).
CORNER_UR_LON_PRODUCT	8	= -180.00000 through +180.00000 degrees.	Longitude value for the upper-right corner of the product (the L1 systems recalculate for the geometrically-corrected product).
CORNER_LL_LAT_PRODUCT	7	= -90.00000 through +90.00000 degrees.	Latitude value for the lower-left corner of the product (the L1 systems recalculate for the geometrically-corrected product).
CORNER_LL_LON_PRODUCT	8	= -180.00000 through +180.00000 degrees.	Longitude value for the lower-left corner of the product (the L1 systems recalculate for the geometrically-corrected product).
CORNER_LR_LAT_PRODUCT	7	= -90.00000 through +90.00000 degrees.	Latitude value for the lower-right corner of the product (the L1 systems recalculate for the geometrically-corrected product).
CORNER_LR_LON_PRODUCT	8	= -180.00000 through +180.00000 degrees.	Longitude value for the lower-right corner of the product (the L1 systems recalculate for the geometrically-corrected product).
CORNER_UL_PROJECTION_X_PRODUCT	14	= -132000000.000 through +132000000.000 Units are feet or meters	Projection X coordinate for the upper-left corner of the product (the L1 systems calculated, geometrically-corrected only).

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description / Remarks
CORNER_UL_PROJECTION_Y_PRODUCT	14	= -132000000.000 through +132000000.000 Units are feet or meters	Projection Y coordinate for the upper-left corner of the product (L1 systems calculated, geometrically-corrected only).
CORNER_UR_PROJECTION_X_PRODUCT	14	= -132000000.000 through +132000000.000 Units are feet or meters	Projection X coordinate for the upper-right corner of the product (L1 systems calculated, geometrically-corrected only).
CORNER_UR_PROJECTION_Y_PRODUCT	14	= -132000000.000 through +132000000.000 Units are feet or meters	Projection Y coordinate for the upper-right corner of the product (L1 systems calculated, geometrically-corrected only).
CORNER_LL_PROJECTION_X_PRODUCT	14	= -132000000.000 through +132000000.000 Units are feet or meters	Projection X coordinate for the lower-left corner of the product (L1 systems calculated, geometrically-corrected only).
CORNER_LL_PROJECTION_Y_PRODUCT	14	= -132000000.000 through +132000000.000 Units are feet or meters	Projection Y coordinate for the lower-left corner of the product (L1 systems calculated, geometrically-corrected only).
CORNER_LR_PROJECTION_X_PRODUCT	14	= -132000000.000 through +132000000.000 Units are feet or meters	Projection X coordinate for the lower-right corner of the product (L1 systems calculated, geometrically-corrected only).
CORNER_LR_PROJECTION_Y_PRODUCT	14	= -132000000.000 through +132000000.000 Units are feet or meters	Projection Y coordinate for the lower-right corner of the product (L1 systems calculated, geometrically-corrected only).
PANCHROMATIC_LINES	5	NNNNN	Product lines for the panchromatic band.
PANCHROMATIC_SAMPLES	5	NNNNN	Product samples for the panchromatic band.
REFLECTIVE_LINES	5	NNNNN	Product lines for the reflective bands.
REFLECTIVE_SAMPLES	5	NNNNN	Product samples for the reflective bands.
THERMAL_LINES	5	NNNNN	Product lines for the thermal bands.
THERMAL_SAMPLES	5	NNNNN	Product samples for the thermal bands.
FILE_NAME_BAND_1	256	“<LANDSAT_PRODUCT_ID>_B1.TIF”	L1-generated external element file name for Band 1.
FILE_NAME_BAND_2	256	“<LANDSAT_PRODUCT_ID>_B2.TIF”	L1-generated external element file name for Band 2.

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description / Remarks
FILE_NAME_BAND_3	256	“<LANDSAT_PRODUCT_ID>_B3.TIF”	L1-generated external element file name for Band 3.
FILE_NAME_BAND_4	256	“<LANDSAT_PRODUCT_ID>_B4.TIF”	L1-generated external element file name for Band 4.
FILE_NAME_BAND_5	256	“<LANDSAT_PRODUCT_ID>_B5.TIF”	L1-generated external element file name for Band 5.
FILE_NAME_BAND_6_VCID_1	256	“<LANDSAT_PRODUCT_ID>_B6_VCID_1.TIF”	L1-generated external element file name for Band 6 VCID 1.
FILE_NAME_BAND_6_VCID_2	256	“<LANDSAT_PRODUCT_ID>_B6_VCID_2.TIF”	L1-generated external element file name for Band 6 VCID 2.
FILE_NAME_BAND_7	256	“<LANDSAT_PRODUCT_ID>_B7.TIF”	L1-generated external element file name for Band 7.
FILE_NAME_BAND_8	256	“<LANDSAT_PRODUCT_ID>_B8.TIF”	L1-generated external element file name for Band 8.
FILE_NAME_BAND_QUALITY	256	“<LANDSAT_PRODUCT_ID>_BQA.TIF”	L1-generated external element file name for the QB.
GROUND_CONTROL_POINT_FILE_NAME	256	“<LANDSAT_PRODUCT_ID>_GCP.txt”	L1-generated external element file name for the GCP, if part of the product.
ANGLE_COEFFICIENT_FILE_NAME	256	“<LANDSAT_PRODUCT_ID>_ANG.txt”	Name of the Angle Coefficient File.
METADATA_ FILE_NAME	256	"<LANDSAT_PRODUCT_ID>_MTL.XXX Where: XXX = an extension indicating an implementation specific format"	Name of the Metadata File.
CPF_ NAME	256	LXSSCPF_YYYYMMDD_yyyymmdd_CC.NNwhere: L = Landsat X= Instrument SS= Satellite (07 for Landsat 7) CPF= 3 letter CPF designator YYYYMMDD = Effective Starting Date yyyymmdd = Effective Ending Date CC= Collection Number (e.g.02) NN= Version Number for this file (Starts with 00)	Archive-generated external element file name for the IAS CPF.

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description / Remarks
DATE_ACQUIRED_GAP_FILL	256	= (YYYY-MM-DD,YYYY-MM-DD,YYYY-MM-DD,YYYY-MM-DD,YYYY-MM-DD)	Acquisition date of the input scenes used for the scan gap fill (up to five input scenes); included only for gap-filled products.
GAP_FILL		=NN.N	Percentage of image pixels present after gap-filling. **Included only for gap-filled products.
END_GROUP	16	= PRODUCT_METADATA	End of the product metadata group.
GROUP	17	= IMAGE_ATTRIBUTES	Beginning of the image attributes group.
CLOUD_COVER	5	0.00-100.00, -1	Cloud coverage (percent) assigned to a WRS scene. Values: -1 = Cloud cover not calculated or assessed.
CLOUD_COVER_LAND	5	= 0.00-100.00, -1	Cloud coverage over land (percent) assigned to a WRS scene. Values: -1 = Cloud cover land not calculated or assessed.
IMAGE_QUALITY	1	0-9, -1	Composite image quality for the bands. Values: 9 = Best. 0 = Worst. -1 = Image quality not calculated or assessed.
SUN_AZIMUTH	11	= -180.00000000 through +180.00000000 degrees. A positive value indicates angles to the east or clockwise from the north. A negative value (-) indicates angles to the west or counterclockwise from the north. Leading zeros are not required.	Sun azimuth angle in degrees for the image center location at the image center acquisition time.
SUN_ELEVATION	10	= -90.00000000 through +90.00000000 degrees. A positive value indicates a daytime scene. A negative value (-) indicates a nighttime scene. Leading zeros are not required.	Sun elevation angle in degrees for the image center location at the image center acquisition time.
EARTH_SUN_DISTANCE	9	= N.NNNNNNN	Measurement (astronomical unit) of the earth to sun distance at the particular day and time of imagery acquisition.
GROUND_CONTROL_POINTS_VERSION	3	= 0 - 999	GCP version used for processing.

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description / Remarks
GROUND_CONTROL_POINTS_ MODEL	3	= 1 - 999	Number of GCPs used in the precision correction process.
GEOMETRIC_RMSE_MODEL	7	= 0.000 – 9999.999	Combined Root Mean Square Error (RMSE) of the geometric residuals (meters) in both across-track and along-track directions measured on the GCPs used in geometric precision correction.
GEOMETRIC_RMSE_MODEL_Y	7	= 0.000 – 9999.999	RMSE of the geometric residuals (meters) measured on the GCPs used in geometric precision correction.
GEOMETRIC_RMSE_MODEL_X	7	= 0.000 – 9999.999	RMSE of the geometric residuals (meters) measured on the GCPs used in geometric precision correction.
SATURATION_BAND_1	1	= “Y” (Yes) = “N” (No) = “U” Unknown	Y = Band contains saturation; N = Band does not contain any saturation.
SATURATION_BAND_2	1	= “Y” (Yes) = “N” (No) = “U” Unknown	Y = Band contains saturation; N = Band does not contain any saturation.
SATURATION_BAND_3	1	= “Y” (Yes) = “N” (No) = “U” Unknown	Y = Band contains saturation; N = Band does not contain any saturation.
SATURATION_BAND_4	1	= “Y” (Yes) = “N” (No) = “U” Unknown	Y = Band contains saturation; N = Band does not contain any saturation.
SATURATION_BAND_5	1	= “Y” (Yes) = “N” (No) = “U” Unknown	Y = Band contains saturation; N = Band does not contain any saturation.
SATURATION_BAND_6_VCID_1	1	= “Y” (Yes) = “N” (No) = “U” Unknown	Y = Band contains saturation; N = Band does not contain any saturation.
SATURATION_BAND_6_VCID_2	1	= “Y” (Yes) = “N” (No) = “U” Unknown	Y = Band contains saturation; N = Band does not contain any saturation.
SATURATION_BAND_7	1	= “Y” (Yes) = “N” (No) = “U” Unknown	Y = Band contains saturation; N = Band does not contain any saturation.
SATURATION_BAND_8	1	= “Y” (Yes) = “N” (No) = “U” Unknown	Y = Band contains saturation; N = Band does not contain any saturation.
END_GROUP	17	= IMAGE_ATTRIBUTES	End of the image attributes group.
GROUP	16	= MIN_MAX_RADIANCE	Beginning of the minimum / maximum radiance group (1G product only).

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description / Remarks
RADIANCE_MAXIMUM_BAND_1	6	= 0.000 – 999.999	Maximum achievable spectral radiance value for Band 1, if part of the product (w/(m^2 sr micron)). In addition, the spectral radiance corresponding to QUANTIZE_CAL_MAX_BAND_1.
RADIANCE_MINIMUM_BAND_1	6	= -999.999 through +999.999	Minimum achievable spectral radiance value for Band 1, if part of the product (w/(m^2 sr micron)). In addition, the spectral radiance corresponding to QUANTIZE_CAL_MIN_BAND_1.
RADIANCE_MAXIMUM_BAND_2	6	= 0.000 – 999.999	Maximum achievable spectral radiance value for Band 2, if part of the product (w/(m^2 sr micron)). In addition, the spectral radiance corresponding to QUANTIZE_CAL_MAX_BAND_2.
RADIANCE_MINIMUM_BAND_2	6	= -999.999 through +999.999	Minimum achievable spectral radiance value for Band 2, if part of the product (w/(m^2 sr micron)). In addition, the spectral radiance corresponding to QUANTIZE_CAL_MIN_BAND_2.
RADIANCE_MAXIMUM_BAND_3	6	= 0.000 – 999.999	Maximum achievable spectral radiance value for Band 3, if part of the product (w/(m^2 sr micron)). In addition, the spectral radiance corresponding to QUANTIZE_CAL_MAX_BAND_3.
RADIANCE_MINIMUM_BAND_3	6	= -999.999 through +999.999	Minimum achievable spectral radiance value for Band 3, if part of the product (w/(m^2 sr micron)). In addition, the spectral radiance corresponding to QUANTIZE_CAL_MIN_BAND_3.

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description / Remarks
RADIANCE_MAXIMUM_BAND_4	6	= 0.000 – 999.999	Maximum achievable spectral radiance value for Band 4, if part of the product (w/(m^2 sr micron)). In addition, the spectral radiance corresponding to QUANTIZE_CAL_MAX_BAND_4.
RADIANCE_MINIMUM_BAND_4	6	= -999.999 through +999.999	Minimum achievable spectral radiance value for Band 4, if part of the product (w/(m^2 sr micron)). In addition, the spectral radiance corresponding to QUANTIZE_CAL_MIN_BAND_4.
RADIANCE_MAXIMUM_BAND_5	6	= 0.000 – 999.999	Maximum achievable spectral radiance value for Band 5, if part of the product (w/(m^2 sr micron)). In addition, the spectral radiance corresponding to QUANTIZE_CAL_MAX_BAND_5.
RADIANCE_MINIMUM_BAND_5	6	= -999.999 through +999.999	Minimum achievable spectral radiance value for Band 5, if part of the product (w/(m^2 sr micron)). In addition, the spectral radiance corresponding to QUANTIZE_CAL_MIN_BAND_5.
RADIANCE_MAXIMUM_BAND_6_VCID_1	6	= 0.000 – 999.999	Maximum achievable spectral radiance value for Band 6 VCID 1, if part of the product (w/(m^2 sr micron)). In addition, the spectral radiance corresponding to QUANTIZE_CAL_MAX_BAND_6_VCID_1.
RADIANCE_MINIMUM_BAND_6_VCID_1	6	= -999.999 through +999.999	Minimum achievable spectral radiance value for Band 6 VCID 1, if part of the product (w/(m^2 sr micron)). In addition, the spectral radiance corresponding to QUANTIZE_CAL_MIN_BAND_6_VCID_1.

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description / Remarks
RADIANCE_MAXIMUM_BAND_6_VCID_2	6	= 0.000 – 999.999	Maximum achievable spectral radiance value for Band 6 VCID 2, if part of the product (w/(m^2 sr micron)). In addition, the spectral radiance corresponding to QUANTIZE_CAL_MAX_BAND_6_VCID_2.
RADIANCE_MINIMUM_BAND_6_VCID_2	6	= -999.999 through +999.999	Minimum achievable spectral radiance value for Band 6 VCID 2, if part of the product (w/(m^2 sr micron)). In addition, the spectral radiance corresponding to QUANTIZE_CAL_MIN_BAND_6_VCID_2.
RADIANCE_MAXIMUM_BAND_7	6	= 0.000 – 999.999	Maximum achievable spectral radiance value for Band 7, if part of the product (w/[m^2 sr micron]); the spectral radiance corresponding to QUANTIZE_CAL_MAX_BAND_7.
RADIANCE_MINIMUM_BAND_7	6	= -999.999 through +999.999	Minimum achievable spectral radiance value for Band 7, if part of the product (w/[m^2 sr micron]); the spectral radiance corresponding to QUANTIZE_CAL_MIN_BAND_7.
RADIANCE_MAXIMUM_BAND_8	6	= 0.000 – 999.999	Maximum achievable spectral radiance value for Band 8, if part of the product (w/[m^2 sr micron]); the spectral radiance corresponding to QUANTIZE_CAL_MAX_BAND_8.
RADIANCE_MINIMUM_BAND_8	6	= -999.999 through +999.999	Minimum achievable spectral radiance value for Band 8, if part of the product (w/[m^2 sr micron]); the spectral radiance corresponding to QUANTIZE_CAL_MIN_BAND_8.
END_GROUP	16	= MIN_MAX_RADIANCE	End of the minimum / maximum radiance group.
GROUP	16	= MIN_MAX_REFLECTANCE	Beginning of the minimum / maximum reflectance group.

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description / Remarks
REFLECTANCE_MAXIMUM_BAND_1	8	= 0.000000-1.000000	Maximum achievable reflectance value for Band 1.
REFLECTANCE_MINIMUM_BAND_1	8	= 0.000000-1.000000	Minimum achievable reflectance value for Band 1.
REFLECTANCE_MAXIMUM_BAND_2	8	= 0.000000-1.000000	Maximum achievable reflectance value for Band 2.
REFLECTANCE_MINIMUM_BAND_2	8	= 0.000000-1.000000	Minimum achievable reflectance value for Band 2.
REFLECTANCE_MAXIMUM_BAND_3	8	= 0.000000-1.000000	Maximum achievable reflectance value for Band 3.
REFLECTANCE_MINIMUM_BAND_3	8	= 0.000000-1.000000	Minimum achievable reflectance value for Band 3.
REFLECTANCE_MAXIMUM_BAND_4	8	= 0.000000-1.000000	Maximum achievable reflectance value for Band 4.
REFLECTANCE_MINIMUM_BAND_4	8	= 0.000000-1.000000	Minimum achievable reflectance value for Band 4.
REFLECTANCE_MAXIMUM_BAND_5	8	= 0.000000-1.000000	Maximum achievable reflectance value for Band 5.
REFLECTANCE_MINIMUM_BAND_5	8	= 0.000000-1.000000	Minimum achievable reflectance value for Band 5.
REFLECTANCE_MAXIMUM_BAND_7	8	= 0.000000-1.000000	Maximum achievable reflectance value for Band 7.
REFLECTANCE_MINIMUM_BAND_7	8	= 0.000000-1.000000	Minimum achievable reflectance value for Band 7.
REFLECTANCE_MAXIMUM_BAND_8	8	= 0.000000-1.000000	Maximum achievable reflectance value for Band 8.
REFLECTANCE_MINIMUM_BAND_8	8	= 0.000000-1.000000	Minimum achievable reflectance value for Band 8.
END_GROUP	16	= MIN_MAX_REFLECTANCE	End of the minimum / maximum reflectance group.
GROUP	19	= MIN_MAX_PIXEL_VALUE	Beginning of the minimum / maximum pixel value group.
QUANTIZE_CAL_MAX_BAND_1	3	= 0 - 255	Maximum possible pixel value for Band 1, if part of the product (Digital Number [DN]).
QUANTIZE_CAL_MIN_BAND_1	1	= 0 - 1	Minimum possible pixel value for Band 1, if part of the product (DN).
QUANTIZE_CAL_MAX_BAND_2	3	= 0 - 255	Maximum possible pixel value for Band 2, if part of the product (DN).
QUANTIZE_CAL_MIN_BAND_2	1	= 0 - 1	Minimum possible pixel value for Band 2, if part of the product (DN).
QUANTIZE_CAL_MAX_BAND_3	3	= 0 - 255	Maximum possible pixel value for Band 3, if part of the product (DN).
QUANTIZE_CAL_MIN_BAND_3	1	= 0 - 1	Minimum possible pixel value for Band 3, if part of the product (DN).

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description / Remarks
QUANTIZE_CAL_MAX_BAND_4	3	= 0 - 255	Maximum possible pixel value for Band 4, if part of the product (DN).
QUANTIZE_CAL_MIN_BAND_4	1	= 0 - 1	Minimum possible pixel value for Band 4, if part of the product (DN)
QUANTIZE_CAL_MAX_BAND_5	3	= 0 - 255	Maximum possible pixel value for Band 5, if part of the product (DN).
QUANTIZE_CAL_MIN_BAND_5	1	= 0 - 1	Minimum possible pixel value for Band 5, if part of the product (DN).
QUANTIZE_CAL_MAX_BAND_6_VCID_1	3	= 0 - 255	Maximum possible pixel value for Band 6 VCID 1, if part of the product (DN).
QUANTIZE_CAL_MIN_BAND_6_VCID_1	1	= 0 - 1	Minimum possible pixel value for Band 6 VCID 1, if part of the product (DN).
QUANTIZE_CAL_MAX_BAND_6_VCID_2	3	= 0 - 255	Maximum possible pixel value for Band 6 VCID 2, if part of the product (DN).
QUANTIZE_CAL_MIN_BAND_6_VCID_2	1	= 0 - 1	Minimum possible pixel value for Band 6 VCID 2, if part of the product (DN).
QUANTIZE_CAL_MAX_BAND_7	3	= 0 - 255	Maximum possible pixel value for Band 7, if part of the product (DN).
QUANTIZE_CAL_MIN_BAND_7	1	= 0 - 1	Minimum possible pixel value for Band 7, if part of the product (DN).
QUANTIZE_CAL_MAX_BAND_8	3	= 0 - 255	Maximum possible pixel value for Band 8, if part of the product (DN).
QUANTIZE_CAL_MIN_BAND_8	1	= 0 - 1	Minimum possible pixel value for Band 8, if part of the product (DN).
END_GROUP	19	= MIN_MAX_PIXEL_VALUE	End of the minimum / maximum pixel value group.
GROUP	18	= PRODUCT_PARAMETERS	Beginning of the product parameters group (both 1R and 1G products).
CORRECTION_GAIN_BAND_1	20	= “CPF” (for CPF gains) = “INTERNAL_CALIBRATION” (for IC gains)	Correction method used by L1 in creating the image for Band 1, if part of the product.
CORRECTION_GAIN_BAND_2	20	= “CPF” (for CPF gains) = “INTERNAL_CALIBRATION” (for IC gains)	Correction method used by L1 in creating the image for Band 2, if part of the product.
CORRECTION_GAIN_BAND_3	20	= “CPF” (for CPF gains) = “INTERNAL_CALIBRATION” (for IC gains)	Correction method used by L1 in creating the image for Band 3, if part of the product.

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description / Remarks
CORRECTION_GAIN_BAND_4	20	= “CPF” (for CPF gains) = “INTERNAL_CALIBRATION” (for IC gains)	Correction method used by L1 in creating the image for Band 4, if part of the product.
CORRECTION_GAIN_BAND_5	20	= “CPF” (for CPF gains) = “INTERNAL_CALIBRATION” (for IC gains)	Correction method used by L1 in creating the image for Band 5, if part of the product.
CORRECTION_GAIN_BAND_6_VCID_1	20	= “CPF” (for CPF gains) = “INTERNAL_CALIBRATION” (for IC gains)	Correction method used by L1 in creating the image for Band 6 VCID 1, if part of the product.
CORRECTION_GAIN_BAND_6_VCID_2	20	= “CPF” (for CPF gains) = “INTERNAL_CALIBRATION” (for IC gains)	Correction method used by L1 in creating the image for Band 6 VCID 2, if part of the product.
CORRECTION_GAIN_BAND_7	20	= “CPF” (for CPF gains) = “INTERNAL_CALIBRATION” (for IC gains)	Correction method used by L1 in creating the image for Band 7, if part of the product.
CORRECTION_GAIN_BAND_8	20	= “CPF” (for CPF gains) = “INTERNAL_CALIBRATION” (for IC gains)	Correction method used by L1 in creating the image for Band 8, if part of the product.
CORRECTION_BIAS_BAND_1	20	= “CPF” (for CPF gains) = “INTERNAL_CALIBRATION” (for IC gains)	Bias correction method used by L1 in creating the image for Band 1, if part of the product.
CORRECTION_BIAS_BAND_2	20	= “CPF” (for CPF gains) = “INTERNAL_CALIBRATION” (for IC gains)	Bias correction method used by L1 in creating the image for Band 2, if part of the product.
CORRECTION_BIAS_BAND_3	20	= “CPF” (for CPF gains) = “INTERNAL_CALIBRATION” (for IC gains)	Bias correction method used by L1 in creating the image for Band 3, if part of the product.
CORRECTION_BIAS_BAND_4	20	= “CPF” (for CPF gains) = “INTERNAL_CALIBRATION” (for IC gains)	Bias correction method used by L1 in creating the image for Band 4, if part of the product.
CORRECTION_BIAS_BAND_5	20	= “CPF” (for CPF gains) = “INTERNAL_CALIBRATION” (for IC gains)	Bias correction method used by L1 in creating the image for Band 5, if part of the product.
CORRECTION_BIAS_BAND_6_VCID_1	20	= “CPF” (for CPF gains) = “INTERNAL_CALIBRATION” (for IC gains)	Bias correction method used by L1 in creating the image for Band 6 VCID 1, if part of the product.
CORRECTION_BIAS_BAND_6_VCID_2	20	= “CPF” (for CPF gains) = “INTERNAL_CALIBRATION” (for IC gains)	Bias correction method used by L1 in creating the image for Band 6 VCID 2, if part of the product.

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description / Remarks
CORRECTION_BIAS_BAND_7	20	= “CPF” (for CPF gains) = “INTERNAL_CALIBRATION” (for IC gains)	Bias correction method used by L1 in creating the image for Band 7, if part of the product.
CORRECTION_BIAS_BAND_8	20	= “CPF” (for CPF gains) = “INTERNAL_CALIBRATION” (for IC gains)	Bias correction method used by L1 in creating the image for Band 8, if part of the product.
GAIN_BAND_1	1	= “L” (for low gain) = “H” (for high gain)	Gain state for Band 1’s first data line, if part of the product.
GAIN_BAND_2	1	= “L” (for low gain) = “H” (for high gain)	Gain state for Band 2’s first data line, if part of the product.
GAIN_BAND_3	1	= “L” (for low gain) = “H” (for high gain)	Gain state for Band 3’s first data line, if part of the product.
GAIN_BAND_4	1	= “L” (for low gain) = “H” (for high gain)	Gain state for Band 4’s first data line, if part of the product
GAIN_BAND_5	1	= “L” (for low gain) = “H” (for high gain)	Gain state for Band 5’s first data line, if part of the product.
GAIN_BAND_6_VCID_1	1	= “L” (for low gain) = “H” (for high gain)	Gain state for Band 6’s first data line, if part of the product-Format 1.
GAIN_BAND_6_VCID_2	1	= “L” (for low gain) = “H” (for high gain)	Gain state for Band 6’s first data line, if part of the product-Format 2.
GAIN_BAND_7	1	= “L” (for low gain) = “H” (for high gain)	Gain state for Band 7’s first data line, if part of the product.
GAIN_BAND_8	1	= “L” (for low gain) = “H” (for high gain)	Gain state for Band 8’s first data line, if part of the product.
GAIN_CHANGE_BAND_1	2	= “HH” (for no gain change) = “LL” (for no gain change) = “LH” (for low to high) = “HL“ (for high to low) = “U” (for unknown)	Presence and direction of gain change for Band 1, if part of the product.
GAIN_CHANGE_BAND_2	2	= “HH” (for no gain change) = “LL” (for no gain change) = “LH” (for low to high) = “HL“ (for high to low) = “U” (for unknown)	Presence and direction of gain change for Band 2, if part of the product.
GAIN_CHANGE_BAND_3	2	= “HH” (for no gain change) = “LL” (for no gain change) = “LH” (for low to high) = “HL“ (for high to low) = “U” (for unknown)	Presence and direction of gain change for Band 3, if part of the product.

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description / Remarks
GAIN_CHANGE_BAND_4	2	= “HH” (for no gain change) = “LL” (for no gain change) = “LH” (for low to high) = “HL“ (for high to low) = “U” (for unknown)	Presence and direction of gain change for Band 4, if part of the product.
GAIN_CHANGE_BAND_5	2	= “HH” (for no gain change) = “LL” (for no gain change) = “LH” (for low to high) = “HL“ (for high to low) = “U” (for unknown)	Presence and direction of gain change for Band 5, if part of the product.
GAIN_CHANGE_BAND_6_VCID_1	2	= “HH” (for no gain change) = “LL” (for no gain change) = “LH” (for low to high) = “HL“ (for high to low) = “U” (for unknown)	Presence and direction of gain change for Band 6 Format 1, if part of the product.
GAIN_CHANGE_BAND_6_VCID_2	2	= “HH” (for no gain change) = “LL” (for no gain change) = “LH” (for low to high) = “HL“ (for high to low) = “U” (for unknown)	Presence and direction of gain change for Band 6 Format 2, if part of the product.
GAIN_CHANGE_BAND_7	2	= “HH” (for no gain change) = “LL” (for no gain change) = “LH” (for low to high) = “HL“ (for high to low) = “U” (for unknown)	Presence and direction of gain change for Band 7, if part of the product.
GAIN_CHANGE_BAND_8	2	= “HH” (for no gain change) = “LL” (for no gain change) = “LH” (for low to high) = “HL“ (for high to low) = “U” (for unknown)	Presence and direction of gain change for Band 8, if part of the product
GAIN_CHANGE_SCAN_BAND_1	1–5	= 0 (for no gain change) = 1-13,875 (for the scan line number)	Scan line number where the first change in band gain was detected; the physical change actually occurred in the previous scan.
GAIN_CHANGE_SCAN_BAND_2	1–5	= 0 (for no gain change) = 1-13,875 (for the scan line number)	Scan line number where the first change in band gain was detected; the physical change actually occurred in the previous scan.
GAIN_CHANGE_SCAN_BAND_3	1–5	= 0 (for no gain change) = 1-13,875 (for the scan line number)	Scan line number where the first change in band gain was detected; the physical change actually occurred in the previous scan.
GAIN_CHANGE_SCAN_BAND_4	1–5	= 0 (for no gain change) = 1-13,875 (for the scan line number)	Scan line number where the first change in band gain was detected; the physical change actually occurred in the previous scan.

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description / Remarks
GAIN_CHANGE_SCAN _BAND_5	1–5	= 0 (for no gain change) = 1-13,875 (for the scan line number)	Scan line number where the first change in band gain was detected; the physical change actually occurred in the previous scan.
GAIN_CHANGE_BAND_6_VCID _1	1–5	= 0 (for no gain change) = 1-13,875 (for the scan line number)	Scan line number where the first change in band gain was detected; the physical change actually occurred in the previous scan.
GAIN_CHANGE_SCAN _BAND_6_VCID_2	1–5	= 0 (for no gain change) = 1-13,875 (for the scan line number)	Scan line number where the first change in band gain was detected; the physical change actually occurred in the previous scan.
GAIN_CHANGE_SCAN _BAND_7	1–5	= 0 (for no gain change) = 1-13,875 (for the scan line number)	Scan line number where the first change in band gain was detected; the physical change actually occurred in the previous scan.
GAIN_CHANGE_SCAN _BAND_8	1–5	= 0 (for no gain change) = 1-13,875 (for the scan line number)	Scan line number where the first change in band gain was detected; the physical change actually occurred in the previous scan.
END_GROUP	18	= PRODUCT_PARAMETERS	End of the product parameters group.
GROUP	21	= RADIOMETRIC_RESCALING	Beginning of the radiometric rescaling parameters group.
RADIANCE_MULT_BAND_1	9	= N.NNNNENN	Multiplicative rescaling factor used to convert calibrated digital numbers to radiance units for Band 1 (w/(m^2 sr um / DN).
RADIANCE_MULT_BAND_2	9	= N.NNNNENN	Multiplicative rescaling factor used to convert calibrated digital numbers to radiance units for Band 2 w/(m^2 sr um / DN).
RADIANCE_MULT_BAND_3	9	= N.NNNNENN	Multiplicative rescaling factor used to convert calibrated digital numbers to radiance units for Band 3 (w/(m^2 sr um / DN).
RADIANCE_MULT_BAND_4	9	= N.NNNNENN	Multiplicative rescaling factor used to convert calibrated digital numbers to radiance units for Band 4 (w/(m^2 sr um / DN).

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description / Remarks
RADIANCE_MULT_BAND_5	9	= N.NNNNENN	Multiplicative rescaling factor used to convert calibrated digital numbers to radiance units for Band 5 (w/(m^2 sr um / DN).
RADIANCE_MULT_BAND_6_VCID_1	9	= N.NNNNENN	Multiplicative rescaling factor used to convert calibrated digital numbers to radiance units for Band 6 VCID 1 (w/(m^2 sr um / DN).
RADIANCE_MULT_BAND_6_VCID_2	9	= N.NNNNENN	Multiplicative rescaling factor used to convert calibrated digital numbers to radiance units for Band 6 VCID 2 (w/(m^2 sr um / DN).
RADIANCE_MULT_BAND_7	9	= N.NNNNENN	Multiplicative rescaling factor used to convert calibrated digital numbers to radiance units for Band 7 (w/(m^2 sr um / DN).
RADIANCE_MULT_BAND_8	9	= N.NNNNENN	Multiplicative rescaling factor used to convert calibrated digital numbers to radiance units for Band 8 (w/(m^2 sr um / DN).
RADIANCE_ADD_BAND_1	9	-9999.99999 through +9999.99999	Additive rescaling factor used to convert calibrated digital numbers to radiance units (W/(m^2 sr um)) for Band 1.
RADIANCE_ADD_BAND_2	9	-9999.99999 through +9999.99999	Additive rescaling factor used to convert calibrated digital numbers to radiance units (W/(m^2 sr um)) for Band 2.
RADIANCE_ADD_BAND_3	9	-9999.99999 through +9999.99999	Additive rescaling factor used to convert calibrated digital numbers to radiance units (W/(m^2 sr um)) for Band 3.
RADIANCE_ADD_BAND_4	9	-9999.99999 through +9999.99999	Additive rescaling factor used to convert calibrated digital numbers to radiance units (W/(m^2 sr um)) for Band 4.
RADIANCE_ADD_BAND_5	9	-9999.99999 through +9999.99999	Additive rescaling factor used to convert calibrated digital numbers to radiance units (W/(m^2 sr um)) for Band 5.

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description / Remarks
RADIANCE_ADD_BAND_6_VCID_1	9	-9999.99999 through +9999.99999	Additive rescaling factor used to convert calibrated digital numbers to radiance units (W/(m^2 sr um)) for Band 6 VCID 1.
RADIANCE_ADD_BAND_6_VCID_2	9	-9999.99999 through +9999.99999	Additive rescaling factor used to convert calibrated digital numbers to radiance units (W/(m^2 sr um)) for Band 6 VCID 2.
RADIANCE_ADD_BAND_7	9	-9999.99999 through +9999.99999	Additive rescaling factor used to convert calibrated digital numbers to radiance units (W/(m^2 sr um)) for Band 7.
RADIANCE_ADD_BAND_8	9	-9999.99999 through +9999.99999	Additive rescaling factor used to convert calibrated digital numbers to radiance units (W/(m^2 sr um)) for Band 8.
REFLECTANCE_MULT_BAND_1	9	= N.NNNNENN	Multiplicative rescaling factor used to convert calibrated digital numbers to reflectance for Band 1 (DN^{-1}).
REFLECTANCE_MULT_BAND_2	9	= N.NNNNENN	Multiplicative rescaling factor used to convert calibrated digital numbers to reflectance for Band 2 (DN^{-1}).
REFLECTANCE_MULT_BAND_3	9	= N.NNNNENN	Multiplicative rescaling factor used to convert calibrated digital numbers to reflectance for Band 3 (DN^{-1}).
REFLECTANCE_MULT_BAND_4	9	= N.NNNNENN	Multiplicative rescaling factor used to convert calibrated digital numbers to reflectance for Band 4 (DN^{-1}).
REFLECTANCE_MULT_BAND_5	9	= N.NNNNENN	Multiplicative rescaling factor used to convert calibrated digital numbers to reflectance for Band 5 (DN^{-1}).
REFLECTANCE_MULT_BAND_7	9	= N.NNNNENN	Multiplicative rescaling factor used to convert calibrated digital numbers to reflectance for Band 7 (DN^{-1}).

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description / Remarks
REFLECTANCE_MULT_BAND_8	9	= N.NNNNENN	Multiplicative rescaling factor used to convert calibrated digital numbers to reflectance for Band 8 (DN^{-1}).
REFLECTANCE_ADD_BAND_1	9	-9.999999 through +9.999999	Additive rescaling factor used to convert calibrated digital numbers to reflectance for Band 1.
REFLECTANCE_ADD_BAND_2	9	-9.999999 through +9.999999	Additive rescaling factor used to convert calibrated digital numbers to reflectance for Band 2.
REFLECTANCE_ADD_BAND_3	9	-9.999999 through +9.999999	Additive rescaling factor used to convert calibrated digital numbers to reflectance for Band 3.
REFLECTANCE_ADD_BAND_4	9	-9.999999 through +9.999999	Additive rescaling factor used to convert calibrated digital numbers to reflectance for Band 4.
REFLECTANCE_ADD_BAND_5	9	-9.999999 through +9.999999	Additive rescaling factor used to convert calibrated digital numbers to reflectance for Band 5.
REFLECTANCE_ADD_BAND_7	9	-9.999999 through +9.999999	Additive rescaling factor used to convert calibrated digital numbers to reflectance for Band 7.
REFLECTANCE_ADD_BAND_8	9	-9.999999 through +9.999999	Additive rescaling factor used to convert calibrated digital numbers to reflectance for Band 8.
END_GROUP	21	= RADIOMETRIC_RESCALING	End of the radiometric rescaling parameters group.
GROUP	17	= THERMAL_CONSTANTS	Beginning of thermal constants group.
K1_CONSTANT_BAND_6_VCID_1	7	= NNNN.NN	Calibration constant for Band 6 radiance to temperature conversion.
K2_CONSTANT_BAND_6_VCID_1	7	= NNNN.NN	Calibration constant for Band 6 radiance to temperature conversion.
K1_CONSTANT_BAND_6_VCID_2	7	= NNNN.NN	Calibration constant for Band 6 radiance to temperature conversion.
K2_CONSTANT_BAND_6_VCID_2	7	= NNNN.NN	Calibration constant for Band 6 radiance to temperature conversion.
END_GROUP	17	= THERMAL_CONSTANTS	End of thermal constants group.
GROUP	21	= PROJECTION_PARAMETERS	Beginning of the projection parameters group.

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description / Remarks
MAP_PROJECTION	4	= “PS” (Polar Stereographic) = ”UTM” (Universal Transverse Mercator)	Map projection used in creating the image.
DATUM	5	= “WGS84”	Datum used in creating the image.
ELLIPSOID	5	= “WGS84”	Ellipsoid used in creating the image.
UTM_ZONE	2	= 1 to 60	Value used to indicate the zone number (used only when MAP_PROJECTION=”UTM “).
VERTICAL_LON_FROM_POLE	12	= –180.0 to +180.0	Vertical longitude from the pole (PS projection only).
TRUE_SCALE_LAT	11	= –90.0 through +90.0	Latitude of true scale (PS projection only).
FALSE_EASTING	18	= -1.0×10^8 to $+1.0 \times 10^8$	False easting (PS projection only).
FALSE_NORTHING	18	= -1.0×10^8 to $+1.0 \times 10^8$	False northing (PS projection only).
GRID_CELL_SIZE_PANCHROMATIC	5	= 5.00–60.00 meters, in increments of 0.001 meters 14.25–60.00 (IAS / LPGS)	Grid cell size used in creating the image for the Pan band, if part of the product.
GRID_CELL_SIZE_REFLECTIVE	5	= 0.00 - 120.00 meters, in increments of 0.01 meters 25.00 – 60.00 (IAS / LPGS)	Grid cell size used in creating the image for Visible and Near Infrared (VNIR) / Short Wavelength Infrared (SWIR) bands, if part of the product.
GRID_CELL_SIZE_THERMAL	5	= 0.00 - 120.00 meters, in increments of 0.01 meters 25.00 – 60.00 (IAS / LPGS)	Grid cell size used in creating the image for the thermal bands, if part of the product.
ORIENTATION	10	= “NOMINAL”, “NORTH_UP”, or “USER”	Orientation used in creating the image.
RESAMPLING_OPTION	28	= “NEAREST_NEIGHBOR”, “CUBIC_CONVOLUTION”, “MODULATION_TRANSFER_FUNCTION”	Resampling option used in creating the image.
SCAN_GAP_INTERPOLATION	3	= 00.0–15.0	Maximum scan gap width to fill by interpolation, in units of ETM+ 30 m detectors / pixels. Note: Included only with single SLC-off and gap-filled products.
END_GROUP	21	= PROJECTION_PARAMETERS	End of the projection parameters group.

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description / Remarks
END_GROUP	148	L1_METADATA_FILE	End of the L1 Metadata File level group.
END			Required standalone parameter signifying the file end.
*ASCII bytes			

Table** 3-2**. L1 Metadata File

3.1.4 L1 Angle Coefficients File

The L1 angle coefficients file can be created during product generation and contains metadata and coefficients that allow solar and satellite viewing angles to be calculated. **Error! Reference source not found.** lists the full contents of the L1 angle coefficients file. It is not provided for TM-A products. The angle coefficients file is text in the ODL format. Refer to http://landsat.usgs.gov for information on using the L1 angle coefficient file.

Parameter Name	Value, Format, and Range	Parameter Description / Remarks
GROUP	= FILE_HEADER	The beginning of the file header ODL group.
LANDSAT_SCENE_ID	ETM = “LE7ppprrrYYYYDDDGGGVV”	The unique Landsat scene identifier.
SPACECRAFT_ID	ETM = “L7_ETM”	Spacecraft from which the data were captured.
WRS_PATH	= 1 – 233	WRS path number for the corresponding scene.
WRS_ROW	= 1 – 248	WRS row number for the corresponding scene.
MODE	= “SLC_ON” = “SLC_OFF”	Indicates whether the scan line corrector is on or off for this scene.
FIRST_SCAN_DIRECTION	= “F” = “R”	Indicates which direction the first scan is going, forward or reverse.
NUMBER_OF_BANDS	ETM = 1 – 9	Number of bands contained in the angle coefficient file.
BAND_LIST	ETM = (1,2,3,4,5,61,62,7,8)	List of spectral bands contained in the angle coefficient file. The number of bands listed is specified by the NUMBER_OF_BANDS parameter.
END_GROUP	= FILE_HEADER	The end of the file header ODL group.
GROUP	= PROJECTION	The beginning of the projection ODL group.
ELLIPSOID_AXES	= (Semi-major, Semi-minor)	WGS84 ellipsoid semi-major and semi-minor axes in meters.

Parameter Name	Value, Format, and Range	Parameter Description / Remarks
MAP_PROJECTION	= “UTM“ = “PS“	The map projection used in creating the image. UTM or PS.
PROJECTION_UNITS	= “METERS”	Map projection units, which are always METERS.
DATUM	= “WGS84”	The datum used in creating the image.
ELLIPSOID	= “WGS84”	The ellipsoid used in creating the image.
UTM_ZONE	= 1 – 60	UTM zone number (1 – 60). Field is absent for non-UTM projections.
PROJECTION_PARAMETERS	= (P_1 … P_{15})	GCTP map projection parameters array with 15 double precision floating point parameters. This is all zeros for UTM. Polar stereographic includes ellipsoid axes, false easting and northing (both 0), latitude of true scale (+/- 71) and the vertical axis longitude (also 0).
UL_CORNER	= (X, Y)	L1TP upper-left corner map projection coordinates in meters (doubles).
UR_CORNER	= (X, Y)	L1TP upper-right corner map projection coordinates in meters (doubles).
LL_CORNER	= (X, Y)	L1TP lower-left corner map projection coordinates in meters (doubles).
LR_CORNER	= (X, Y)	L1TP lower-right corner map projection coordinates in meters (doubles).
END_GROUP	= PROJECTION	The end of the projection ODL group.
GROUP	= EPHEMERIS	The beginning of the ephemeris ODL group.
EPHEMERIS_EPOCH_YEAR	= YYYY	Year of ephemeris starting time epoch (integer).
EPHEMERIS_EPOCH_DAY	= DDD	Day of year of ephemeris epoch (integer).
EPHEMERIS_EPOCH_SECONDS	= Seconds	Seconds of day of ephemeris epoch (double)
NUMBER_OF_POINTS	= 1 – 99999	Number of ephemeris points contained in the next four parameter fields.
EPHEMERIS_TIME	= ($time_1$ … $time_N$)	Array of double precision ephemeris sample time offsets (from epoch) in seconds.
EPHEMERIS_ECEF_X	= (X_1 … X_N)	Array of double precision ephemeris samples Earth Centered Earth Fixed (ECEF) X coordinates in meters.

Parameter Name	Value, Format, and Range	Parameter Description / Remarks
EPHEMERIS_ECEF_Y	= (Y_1 … Y_N)	Array of double precision ephemeris samples ECEF Y coordinates in meters.
EPHEMERIS_ECEF_Z	= (Z_1 … Z_N)	Array of double precision ephemeris samples ECEF Z coordinates in meters.
END_GROUP	= EPHEMERIS	The end of the ephemeris ODL group.
GROUP	= SOLAR_VECTOR	The beginning of the solar vector ODL group.
SOLAR_EPOCH_YEAR	= YYYY	Year of solar start time (integer).
SOLAR_EPOCH_DAY	= DDD	Day of year of solar start time (integer).
SOLAR_EPOCH_SECONDS	= Seconds	Seconds of day of solar start time (double).
EARTH_SUN_DISTANCE	= Distance	Measurement of the earth to sun distance at the particular day and time of imagery acquisition. Astronomical Unit (AU) of measurement.
NUMBER_OF_POINTS	= 1 – 99999	Number of solar vector points contained in the next four parameter fields.
SAMPLE_TIME	= ($time_1$ … $time_N$)	Array of double precision solar vector sample time offsets (from epoch) in seconds.
SOLAR_ECEF_X	= (X_1 … X_N)	Array of double precision solar vector samples ECEF X direction.
SOLAR_ECEF_Y	= (Y_1 … Y_N)	Array of double precision solar vector samples ECEF Y direction.
SOLAR_ECEF_Z	= (Z_1 … Z_N)	Array of double precision solar vector samples ECEF Z direction.
END_GROUP	= SOLAR_VECTOR	The end of the solar vector ODL group.
GROUP	= SCAN_TIME_POLY	The beginning of the Rational Polynomial Coefficients (RPC) scan time ODL group. The "##" corresponds to the scan direction (0,1).
SCAN_TIME_POLY_NCOEFF	= 3 = 4	The number of coefficients to use to map the scan time polynomial.
SCAN_TIME_POLY_NUMBER_DIRECTIONS	= 2	The number of scan directions.
SCAN_TIME##_MEAN_ACTIVESCAN	= Mean scan time	Mean time of the scan line per direction.
SCAN_TIME##_MEAN_EOL	= Mean end of line time	Mean time of the end of the scan line per direction

Parameter Name	Value, Format, and Range	Parameter Description / Remarks
SCAN_TIME##_POLY_COEFF	= (coeff, coeff, coeff, coeff)	The scan time polynomial coefficients per direction. The number of coefficients is always 4. If SCAN_TIME_POLY_NCOEFF is 3, the fourth coefficient is zero.
END_GROUP	= SCAN_TIME-POLY	The end of the Scan Time Poly group.
GROUP	= RPC_BAND##	The beginning of the RPC Band ## ODL group. The "##" corresponds to the band number (1 – 11). This group is repeated for every band that is present.
BAND##_LINES_PER_SCAN	= 1 – 16	Number of data lines in a scan line.
BAND##_NUMBER_OF_DIRECTIONS	= 1 – 2	Number of scan directions.
BAND##_NUM_L1T_LINES	= 1 – 99999	Number of lines in the L1TP product.
BAND##_NUM_L1T_SAMPS	= 1 – 99999	Number of samples in the L1TP product.
BAND##_NUM_L1R_LINES	= 1 – 99999	Number of lines in the L1R product.
BAND##_NUM_L1R_SAMPS	= 1 – 99999	Number of samples in the L1R product.
BAND##_PIXEL_SIZE	= L1TP pixel size	L1TP pixel size in meters.
BAND##_START_TIME	= Start Time	L1R image start time in seconds from the ephemeris epoch.
BAND##_LINE_TIME	= Seconds per line	L1R image line time increment in seconds.
BAND##_MEAN_HEIGHT	= Mean Height	Mean height offset over the scene for the RPC angle model (double).
BAND##_MEAN_L1R_LINE_SAMP	= (Line, Sample)	Mean L1R line and sample offsets for the RPC angle model (doubles).
BAND##_MEAN_L1T_LINE_SAMP	= (Line, Sample)	Mean L1TP line and sample offsets for the RPC angle model (doubles).
BAND##_MEAN_SAT_VECTOR	= (X, Y, Z)	Mean satellite view vector for the RPC angle model (doubles).
BAND##_SAT_X_NUM_COEF	= (a_0 … a_9)	Array (ten elements) of double precision numerator polynomial coefficients for the satellite view vector X coordinate.
BAND##_SAT_X_DEN_COEF	= (b_1 ... b_9)	Array (nine elements) of double precision denominator polynomial coefficients for the satellite view vector X coordinate.

Parameter Name	Value, Format, and Range	Parameter Description / Remarks
BAND##_SAT_Y_NUM_COEF	= (a_0 … a_9)	Array (ten elements) of double precision numerator polynomial coefficients for the satellite view vector Y coordinates.
BAND##_SAT_Y_DEN_COEF	= (b_1 ... b_9)	Array (nine elements) of double precision denominator polynomial coefficients for the satellite view vector Y coordinate.
BAND##_SAT_Z_NUM_COEF	= (a_0 … a_9)	Array (ten elements) of double precision numerator polynomial coefficients for the satellite view vector Z coordinates.
BAND##_SAT_Z_DEN_COEF	= (b_1 ... b_9)	Array (nine elements) of double precision denominator polynomial coefficients for the satellite view vector Z coordinate.
BAND##_MEAN_SUN_VECTOR	= (X, Y, Z)	Mean sun vector for the RPC angle model (doubles).
BAND##_SUN_X_NUM_COEF	= (a_0 … a_9)	Array (ten elements) of double precision numerator polynomial coefficients for the sun vector X coordinate.
BAND##_SUN_X_DEN_COEF	= (b_1 ... b_9)	Array (nine elements) of denominator polynomial coefficients for the sun vector X coordinate.
BAND##_SUN_Y_NUM_COEF	= (a_0 … a_9)	Array (ten elements) of double precision numerator polynomial coefficients for the sun vector Y coordinates.
BAND##_SUN_Y_DEN_COEF	= (b_1 ... b_9)	Array (nine elements) of double precision denominator polynomial coefficients for the sun vector Y coordinates.
BAND##_SUN_Z_NUM_COEF	= (a_0 … a_9)	Array (ten elements) of double precision numerator polynomial coefficients for the sun vector Z coordinates.
BAND##_SUN_Z_DEN_COEF	= (b_1 ... b_9)	Array (nine elements) of double precision denominator polynomial coefficients for the sun vector Z coordinates.
BAND##_DIR##_MEAN_HEIGHT	= Mean Height	Mean height offset for the scan direction ## L1TP to L1R RPC model. The ## behind the DIR denotes the scan direction. This field and the following six fields are repeated for each scan direction present in the list for the current band and each following band.

Parameter Name	Value, Format, and Range	Parameter Description / Remarks
BAND##_DIR##_MEAN_L1R_LINE_SAMP	= (Line, Sample)	Mean L1R line and sample offsets for the DIR## L1TP to L1R RPC model (doubles).
BAND##_DIR##_MEAN_L1T_LINE_SAMP	= (Line, Sample)	Mean L1TP line and sample offsets for the DIR## L1TP to L1R RPC model (doubles).
BAND##_DIR##_LINE_NUM_COEF	= (a_0 … a_4)	Array (five elements) of numerator polynomial coefficients for the DIR## L1R line RPC model (doubles).
BAND##_DIR##_LINE_DEN_COEF	= (b_1 … b_4)	Array (four elements) of denominator polynomial coefficients for the DIR## L1R line RPC model (doubles).
BAND##_DIR##_SAMP_NUM_COEF	= (c_0 … c_4)	Array (five elements) of numerator polynomial coefficients for the DIR## L1R sample RPC model (doubles).
BAND##_DIR##_SAMP_DEN_COEF	= (d_1 … d_4)	Array (four elements) of denominator polynomial coefficients for the DIR## L1R sample RPC model (doubles).
END_GROUP	= RPC_BAND##	The end of the RPC BAND ## ODL group. This group is followed by the next RPC_BAND## ODL group (if present).

Table 3-3. Angle Coefficients File

3.1.5 GCP File

The GCP file included with an L1TP product is written in ASCII format and contains a header followed by records, one on each line. Each record corresponds to a single GCP. Each record has eight column headings and looks similar to **Error! Reference source not found.**.

Example GCP Output File

Tue. Apr. 22, 2014 LANDSAT 7 Time: 23:49
Image Assessment System
GCP Residual Report

WOID: L11089406 Path/Row: 121 / 031

LOR Reference Image: L71EDC1114113030100_HDF.141130431
Acquisition Date: Apr 23, 2014

Band Number: 5

GLS date for each WRS-2 path/row used:

Path	Row	Date
121	031	2000-09-07

Point_ID	Latitude (deg)	Longitude (deg)	Height (meters)	Across Scan Residual (meters)	Along Scan Residual (meters)	Residual In y dir (meters)	Residual in x dir (meters)
1210310005_01	40.995102	120.792671	116.980	3.187	-0.035	3.138	0.680
1210310011_01	41.699272	119.728705	768.545	-1.486	-1.305	-1.174	-1.606
1210310014_01	41.430523	120.482506	270.023	-4.525	3.553	-5.190	2.459
1210310018_01	41.234108	119.510446	600.639	-2.249	2.051	-2.665	1.495
1210310021_01	41.596187	119.918554	757.540	1.927	3.509	1.089	3.844
1210310028_01	41.246874	119.676936	624.581	-0.548	-2.572	0.026	-2.632
1210310031_01	41.039135	120.602766	143.338	1.366	-0.364	1.430	-0.047
1210310033_01	41.853427	120.261083	557.098	-0.568	-3.472	0.217	-3.510
1210310034_01	41.363355	119.668859	574.467	0.640	-0.626	0.749	-0.473
1210310037_01	41.825961	120.695719	225.462	-6.367	5.361	-7.384	3.813
1210310049_01	41.844592	120.164266	764.538	0.349	0.358	0.257	0.425
1210310056_01	41.120692	119.476810	557.885	1.806	2.328	1.225	2.665
1210310057_01	41.730156	119.684579	859.600	0.481	-4.816	1.521	-4.590

Table 3-4. Example GCP Output File

Section 4 Product Packaging

L1 products are available for distribution via HTTP download. The following provides information on the distribution method for the available L1 product formats.

4.1 Electronic Transfer

Products available via electronic transfer also include the L1 volume descriptor (readme file) with the same file names as listed. When data are packaged and ready for distribution, they are stored in directories on the production online cache for retrieval.

The LPGS GZips (compression) all standard products for distribution. Each individual file within the scene is GZipped.

Section 5 Software Tools

A variety of public domain software tools is available for processing the L1 distribution product in either an HDF or an independent computing environment.

5.1 ODL Parser

The University of Colorado's Laboratory for Atmospheric and Space Physics (LASP) originally implemented the ODL parser (Version 1.0) incorporated into the Science Data Processing (SDP) Toolkit. The Jet Propulsion Laboratory (JPL) enhanced the ODL parser in building their Planetary Data System. IAS modified this enhanced version, available at http://pds.nasa.gov/tools/. LPGS uses this IAS-modified version.

The IAS-modified version should be particularly useful to those operating in a non-HDF-Earth Observing System (EOS) environment. The software stands alone and reads the L0Rp or L1 MTL external elements and the CPF.

Appendix A Projection Parameters

This appendix contains the map projection parameters used in the USGS projection parameters (Table A-1 and Table A-2).

Projection Name Mnemonic	Array Element							
	1	2	3	4	5	6	7	8
PS	SMajor	SMinor			LongPol	TrueScale	FE	FN
UTM	Lon/Z	Lat/Z						

Table A-1. USGS Projection Parameters – Projection Transformation Package Projection Parameters (Elements 1–8)

Projection Name Mnemonic	Array Element						
	9	10	11	12	13	14	15
PS							
UTM							

Table A-2. USGS Projection Parameters – Projection Transformation Package Projection Parameters (Elements 9–15)

Where	Lon/Z	=	Longitude of any point in the UTM zone or zero
	Lat/Z	=	Latitude of any point in the UTM zone or zero
	SMajor	=	Semi-major axis of ellipsoid If zero, Clarke 1866 in m is assumed
	SMinor	=	If less than zero, eccentricity squared of the ellipsoid If zero, a spherical form is assumed If greater than zero, the semi-major axis of ellipsoid
	Sphere	=	Radius of the reference sphere If zero, 6370997 m is used
	Stdpar	=	Latitude of the standard parallel
	Stdpr1	=	Latitude of the first standard parallel
	Stdpr2	=	Latitude of the second standard parallel
	CentMer	=	Longitude of the central meridian
	OriginLat	=	Latitude of the projection origin
	FE	=	False easting in the same units as the semi-major axis
	FN	=	False northing in the same units as the semi-major axis
	LongPol	=	Longitude down below pole of map
	TrueScale	=	Latitude of true scale
	Factor	=	Scale factor at the central meridian (TM) or center of projection (Oblique Mercator Type A (OMA) / Oblique Mercator Type B (OMB))
	CentLon	=	Longitude of the center of projection
	CenterLat	=	Latitude of the center of projection
	Height	=	Height of the perspective point
	Long1	=	Longitude of the first point on the center line
	Long2	=	Longitude of the second point on the center line
	Lat1	=	Latitude of the first point on the center line
	Lat2	=	Latitude of the second point on the center line
	AziAng	=	Azimuth angle east of north of the center line
	AzmthPt	=	Longitude of the point on the central meridian where azimuth occurs
	Satnum	=	Landsat satellite number
	Path	=	Landsat path number (use WRS-1 for Landsat 1, 2, and 3, and WRS-2 for Landsat 4, 5, 6, or 7)
	Shapem	=	Oval shape parameter m
	Shapen	=	Oval shape parameter n
	Angle	=	Oval rotation angle

Table A-3. USGS Projection Parameters Key

Note: All array elements with blank fields are set to zero. All angles (latitudes, longitudes, azimuths, etc.) are entered in packed degrees / minutes / seconds (DDDMMMSSS.SS) format.

References

Please see http://landsat.usgs.gov/tools_acronyms_ALL.php for a list of acronyms.

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