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Department of the Interior
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Landsat 7 (L7)
Enhanced Thematic Mapper Plus (ETM+)
Collection 2 (C2) Level 1 (L1)
Data Format Control Book (DFCB)

Version 3.0

September 2020

USGS
science for a changing world

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Executive Summary

This Data Format Control Book (DFCB) presents detailed data formats of the Landsat 7 Collection 2 (C2) Level 1 (L1) products that the Landsat Product Generation System (LPGS) generates. This processing system produces L1 output files from Level 0 Reformatted (L0R) images. Images are produced in Cloud Optimized Geographic Tagged Image File Format (GeoTIFF) (COG).

The Landsat Data Processing and Archive System (DPAS) Configuration Control Board (CCB) maintains and controls this DFCB. Staff may update or revise this document only upon Landsat DPAS CCB approval. Please direct comments and questions regarding this DFCB to the following:

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Section 1 Introduction

1.1 Background

The goal of Landsat is to continue the collection, archival, and distribution of multispectral imagery affording global, synoptic, and repetitive coverage of the Earth's land surfaces at a scale where natural and human-induced changes can be detected, differentiated, characterized, and monitored over time. The Landsat programmatic goals are stated in the United States Code, Title 15 Chapter 82 "Land Remote Sensing Policy" (derived from the Land Remote Sensing Policy Act of 1992). This policy requires that the Landsat Project provide data into the future that are sufficiently consistent with previous Landsat data to allow the detection and quantitative characterization of changes in or on the surface of the Earth. The highly successful Landsat series of missions have provided satellite coverage of the Earth's continental surfaces since 1972. The data from these missions constitute the longest continuous record of Earth's surface as seen from space.

1.2 Purpose and Scope

This Data Format Control Book (DFCB) provides a high-level description of the Landsat 7 C2 L1 distribution product. It is intended for C2 L1 product recipients. This DFCB describes the formats and data contents of the C2 L1 output files. The output format generated by the LPGS for distribution is COG.

The file formats contained in this DFCB are applicable to the C2 L1 products that LPGS generates at the U.S. Geological Survey (USGS) Earth Resources Observation and Science (EROS) Center.

1.3 Document Organization

This document contains the following sections:

- Section 1 provides an introduction
- Section 2 provides an overview of C2 L1 output files
- Section 3 provides the storage format for the data
- Section 4 describes the product
- Appendix A provides map projection parameters
- Appendix B provides a list of acronyms
- The References section provides a list of reference documents

1.4 Terminology

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 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 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

Level 1 Systematic (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 bands, COG formatted 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 — 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 Precision 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 precision/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 — A global-notation system for Landsat data. The WRS indexes orbits (paths) and scene centers (rows) into a global grid system. 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. A 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-2 structure, each translating to approximately 24 seconds of flight.

1.5 Level 0 (L0) Pre-Archive Processing

A basic knowledge of the 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 reformat 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 to the focal plane array engineering design. All LPS Zero Reformatted (0R) data 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 C2 L1 Output Files

This section provides an overview of the C2 L1 output files.

2.1 L1GS / L1GT / L1TP Output Files Overview

Standard L1TP products, which are Digital Number (DN) products in an unsigned 8-bit integer format, can be converted to Top of Atmosphere (TOA) reflectance using scaling factors provided in the product metadata. Refer to LSDS-31 Landsat 7 System Calibration Parameter File (CPF) Definition for definitions of the reflectance conversion and the rescaling values used to process the L1 products. The CPF used to process a specific scene can be accessed through the USGS Landsat website (https://landsat.usgs.gov).

The L1GS digital image is radiometrically and geometrically corrected. The L1TP product 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. L1GS, L1GT, and L1TP are all available as COG files.

L1 products are available for download at no charge and are generated using a standard set of parameters. 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 — COG
- 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])

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 Global Land Survey [GLS])
- Map projection: — UTM only (need to match GLS) No +/– 1 zone option
- Orientation: — NUP only (need to match GLS)

Table 2-1 lists the specifications for the ETM+ bands, Table 2-2 lists the specifications for the Quality Assessment (QA) bands, Table 2-3 details the L1 product components included with each processing level.

Band Number	Identifier FT	Data Type	Units	Fill	Range
1	B1	UINT8	W/(m^2 sr um)	0 (No Data)	1 through 255
2	B2	UINT8	W/(m^2 sr um)	0 (No Data)	1 through 255
3	B3	UINT8	W/(m^2 sr um)	0 (No Data)	1 through 255
4	B4	UINT8	W/(m^2 sr um)	0 (No Data)	1 through 255
5	B5	UINT8	W/(m^2 sr um)	0 (No Data)	1 through 255
6L	B6_VCID_1	UINT8	W/(m^2 sr um)	0 (No Data)	1 through 255
6H	B6_VCID_2	UINT8	W/(m^2 sr um)	0 (No Data)	1 through 255
7	B7	UINT8	W/(m^2 sr um)	0 (No Data)	1 through 255
8	B8	UINT8	W/(m^2 sr um)	0 (No Data)	1 through 255

Table 2-1. ETM+ Bands Specifications

Identifier FT	Band Name	Data Type	Units	Range
QA_PIXEL	QA Band	UINT16	Bit Index	0 through 65535
QA_RADSAT	Radiometric Saturation and Dropped Pixel QA Band	UINT16	Bit Index	0 through 65535

Table 2-2. ETM+ Quality Assessment Bands Specifications

Component	L1GS	L1GT	L1TP
L1 image file (COG) (for each band)	X	X	X
L1 Metadata files (text [.txt] and XML [.xml])	X	X	X
GCP file (text [.txt] file)			X
Gap Mask file (COG) (for each band)	SLC-off	SLC-off	SLC-off
Quality Assessment (QA) Band files (COG)	X	X	X
Angle Coefficient File (txt)	X	X	X
Band 4 View (sensor) and Solar Angle Band files (COG)	X	X	X

Table 2-3. L1 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 COG 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 L1 Metadata (MTL) file.

2.3 Naming Convention

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

LXSS_LLLL_PPPRRR_YYYYMMDD_yyyymmdd_CC_TX_FT.ext

Identifier	Description
L	Landsat
X	Sensor: E = ETM+
SS	Landsat satellite (07 for Landsat 7)
LLLL	Processing level (L1TP, L1GT, L1GS)
PPP	Satellite orbit location in reference to the Worldwide Reference System-2 (WRS-2) path of the product
RRR	Satellite orbit location in reference to the WRS-2 row of the product
YYYY	Acquisition year of the image
MM	Acquisition month of the image
DD	Acquisition day of the image
yyyy	Processing year of the image
mm	Processing month of the image
dd	Processing day of the image
CC	Collection number (e.g., 02)
TX	Collection category: "RT" for Real-Time, "T1" for Tier 1 (highest quality), "T2" for Tier 2
_FT	File type, where FT equals one of the following: image band file number (B1–B5, B6_VCID_1, B6_VCID_2, B7-B8), VAA (Band 4 View (sensor) Azimuth Angle), VZA (Band 4 View (sensor) Zenith Angle), SAA (Band 4 Solar Azimuth Angle), SZA (Band 4 Solar Zenith Angle), MTL (metadata file), QA_PIXEL (QA Band file), QA _RADSAT (Radiometric saturation and Dropped pixel QA Band), MD5 (checksum file), ANG (angle coefficient file), GCP (Ground Control Point)
.ext	File extension, where .TIF equals COG file extension, .xml equals XML extension (metadata), and .txt equals text extension (ODL and GCP)

Table 2-4. File Naming Convention

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

LXSS_LLLL_PPPRRR_YYYYMMDD_yyyymmdd_CC_TX_GM_FT.ext

Identifier	Description
L	Landsat
X	Sensor: E = ETM+
SS	Landsat satellite (07 for Landsat 7)
LLLL	Processing level (L1TP, L1GT, L1GS)
PPP	Satellite orbit location in reference to the Worldwide Reference System-2 (WRS-2) path of the product
RRR	Satellite orbit location in reference to the WRS-2 row of the product
YYYY	Acquisition year of the image
MM	Acquisition month of the image
DD	Acquisition day of the image
yyyy	Processing year of the image
mm	Processing month of the image
dd	Processing day of the image
CC	Collection number (e.g., 02)
TX	Collection category: "RT" for Real-Time, "T1" for Tier 1 (highest quality), "T2" for Tier 2
GM	Gap Mask
FT	File type, where FT equals one of the following: image band file number (B1–B5, B6_VCID_1, B6_VCID_2, B7-B8)
.ext	File extension, where .TIF equals COG file extension

Table 2-5. Gap Mask File-Naming Convention

2.3.1 Example File Names

2.3.1.1 Image Files

LE07_L1TP_029030_20010719_20191001_02_T1_B1.TIF
LE07_L1TP_029030_20010719_20191001_02_T1_B2.TIF
LE07_L1TP_029030_20010719_20191001_02_T1_B3.TIF
LE07_L1TP_029030_20010719_20191001_02_T1_B4.TIF
LE07_L1TP_029030_20010719_20191001_02_T1_B5.TIF
LE07_L1TP_029030_20010719_20191001_02_T1_B6_VCID_1.TIF
LE07_L1TP_029030_20010719_20191001_02_T1_B6_VCID_2.TIF
LE07_L1TP_029030_20010719_20191001_02_T1_B7.TIF
LE07_L1TP_029030_20010719_20191001_02_T1_B8.TIF

2.3.1.2 Band 4 Angle Files

LE07_L1TP_029030_20010719_20191001_02_T1_VAA.TIF
LE07_L1TP_029030_20010719_20191001_02_T1_VZA.TIF
LE07_L1TP_029030_20010719_20191001_02_T1_SAA.TIF
LE07_L1TP_029030_20010719_20191001_02_T1_SZA.TIF

2.3.1.3 QA Band

LE07_L1TP_029030_20010719_20191001_02_T1_QA_PIXEL.TIF

2.3.1.4 Radiometric Saturation and Dropped Pixel QA Band

LE07_L1TP_029030_20010719_20191001_02_T1_QA_RADSAT.TIF

2.3.1.5 Metadata

LE07_L1TP_029030_20010719_20191001_02_T1_MTL.txt
LE07_L1TP_029030_20010719_20191001_02_T1_MTL.xml

2.3.1.6 Angle Coefficient File

LE07_L1TP_029030_20010719_20191001_02_T1_ANG.txt

2.3.1.7 Ground Control Point File

LE07_L1TP_029030_20010719_20161001_01_T1_GCP.txt

2.3.1.8 Gap Mask Files

LE07_L1TP_029030_20010719_20191001_02_T1_GM_B1.TIF
LE07_L1TP_029030_20010719_20191001_02_T1_GM_B2.TIF
LE07_L1TP_029030_20010719_20191001_02_T1_GM_B3.TIF
LE07_L1TP_029030_20010719_20191001_02_T1_GM_B4.TIF
LE07_L1TP_029030_20010719_20191001_02_T1_GM_B5.TIF
LE07_L1TP_029030_20010719_20191001_02_T1_GM_B6_VCID_1.TIF
LE07_L1TP_029030_20010719_20191001_02_T1_GM_B6_VCID_2.TIF
LE07_L1TP_029030_20010719_20191001_02_T1_GM_B7.TIF
LE07_L1TP_029030_20010719_20191001_02_T1_GM_B8.TIF

2.3.1.9 Checksum

LE07_L1TP_029030_20010719_20191001_02_T1_MD5.txt

Section 3 L1 Output File Formats

This section describes the storage format for the data. Refer to LSDS-1388 Landsat Cloud Optimized GeoTIFF (COG) Data Format Control Book (DFCB) for a more detailed description of COG. The Geospatial Data Abstraction Library (GDAL) NODATA tag is used to indicate, in conjunction with the value for the pixel, which pixel(s) have no data for applicable bands. If GDAL's NODATA tag is included for the band, it is mentioned in this section.

3.1 GeoTIFF

The Geographic Tagged Image File Format (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 L1GT 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 COG file; this file is in 8-bit unsigned integers. The GDAL_NODATA tag defines the value of 0 to be the no data value for these bands.

The gap mask files do not have reduced-resolution overview layers for the COG files.

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.

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

3.1.1.1.1 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.

3.1.1.1.2 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 Transverse Mercator (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 TIFF

TIFF is a tag-based file format for storing raster images.

3.1.2.1 TIFF Tags

TIFF tags are embedded in the same file as the TIFF image. TIFF tags are found in the header and in Image File Directories (IFDs) in a file.

3.1.2.1.1 TIFF Private Tag

This TIFF private tag is used to indicate that a GDAL's NODATA value is specified. This tag is only supported by the GDAL library.

3.1.2.1.2 Description

The, unofficial, TIFF private tag used for GDAL's NODATA tag. The TIFF field has the pixel value which represents no information is available for a pixel.

3.1.2.1.3 Parameters

Tag = 42113
Type = ASCII
N = variable

3.2 QA Band File

The output from the CFMask algorithm is used as an input for the Quality Band Application, which calculates values for all fields in the QA Band file. The QA Band contains quality statistics gathered from the image data and cloud mask information for the scene. The QA Band file is an unsigned 16-bit COG image with the same dimensions as the L1 scene. See LSDS-1388 for more details on COG. 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. Table 3-2 shows the bits being set to artifact mapping.

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

A 3x3 pixel window is used for setting cloud dilation.

Bit	Flag Description	Values
0	Fill	0 for image data 1 for fill data
1	Dilated Cloud	0 for cloud is not dilated or no cloud 1 for cloud dilation
2	Unused	Unused
3	Cloud	0 for cloud confidence is not high 1 for high confidence cloud
4	Cloud Shadow	0 for Cloud Shadow Confidence is not high 1 for high confidence cloud shadow
5	Snow	0 for Snow/Ice Confidence is not high 1 for high confidence snow cover
6	Clear	0 if Cloud or Dilated Cloud bits are set 1 if Cloud and Dilated Cloud bits are not set
7	Water	0 for land or cloud 1 for water
8-9	Cloud Confidence	00 for no confidence level set 01 Low confidence 10 Medium confidence 11 High confidence
10-11	Cloud Shadow Confidence	00 for no confidence level set 01 Low confidence 10 Reserved 11 High confidence
12-13	Snow/Ice Confidence	00 for no confidence level set 01 Low confidence 10 Reserved 11 High confidence
14-15	Unused	Unused

Table 3-2. QA Band Bit Description

3.3 Radiometric Saturation and Dropped Pixel QA Band File

The radiometric saturation QA Band indicates which sensor band(s) are saturated. Table 3-3 shows which bits are for band data saturation and which bit is for dropped pixel. Radiometric saturation can occur under two situations:

1. When the processed L1TP / L1GT product's saturated pixels have the maximum unsigned 8-bit value of 255.
2. When a sensor is saturated during data capture. This happens when the N bit ETM+ sensor reaches a value of (2^N-1) DN. N = 8 bits for ETM+.

Bit	Flag Description	Values
0	Band 1 Data Saturation	0 no saturation 1 saturated data
1	Band 2 Data Saturation	0 no saturation 1 saturated data
2	Band 3 Data Saturation	0 no saturation 1 saturated data
3	Band 4 Data Saturation	0 no saturation 1 saturated data
4	Band 5 Data Saturation	0 no saturation 1 saturated data
5	Band 6L Data Saturation	0 no saturation 1 saturated data
6	Band 7 Data Saturation	0 no saturation 1 saturated data
7	Unused	0 not checked
8	Band 6H Data Saturation	0 no saturation 1 saturated data
9	Dropped Pixel	0 Pixel present 1 detector doesn't have a value – no data
10	Unused	0
11	Unused	0
12	Unused	0
13	Unused	0
14	Unused	0
15	Unused	0

Table 3-3. Radiometric Saturation and Dropped Pixel QA Band Bit Description

3.4 Band 4 Angle Bands

The angles are calculated per pixel for the scene. All of the angle band files have units of hundredths of degrees. Zenith and azimuth angles for solar illumination are calculated, and each is output to a separate band file. Zenith and azimuth angles for sensor viewing are also calculated, each is output to a separate band file. There are four Band 4 angle bands in total. All four files are for the Band 4 image file.

3.5 L1 Metadata Files

The L1 metadata files are created during product generation and contain information specific to the product ordered. One of the metadata files is text in the Object Description Language (ODL) format. All of the parameters contained in the metadata file using ODL format are also in a separate metadata file using Extensible Markup Language (XML) format.

Table 3-4 lists the full contents of the L1 ODL metadata file. Table 3-5 shows the structure of the L1 XML metadata file. Table 3-5 does not show every possible value associated with each parameter name like Table 3-4 does.

The PRODUCT_CONTENTS group contains information about files in the product (e.g., it includes file names and the data type for the GeoTIFF files). Most of the parameters

and parameter values in PRODUCT_CONTENTS are duplicates of the same parameter and parameter values in LEVEL1_PROCESSING_RECORD.

Parameter Name	Value, Format, and Range	Parameter Description / Remarks
GROUP	= LANDSAT_METADATA_FILE	The beginning of the first-level ODL group. It indicates the start of the Landsat metadata file group.
GROUP	= PRODUCT_CONTENTS	The beginning of the product contents group.
ORIGIN	= “Image courtesy of the U.S. Geological Survey”	Origin of the product.
DIGITAL_OBJECT_IDENTIFIER	= “https://doi.org/10.5066/P9TU80IG”	Digital Object Identifier for Level 1 ETM+. For more information on Digital Object Identifiers, visit https://www.doi.org.
LANDSAT_PRODUCT_ID	= “LXSS_LLLL_PPPRRR_YYYYMMDD_yyyymmdd_CC_TX”	Landsat uses the “LXSS_LLLL_PPPRRR_YYYYMMDD_yyyymmdd_CC_TX” format, where: L = Landsat X = Sensor SS = Satellite (07) LLLL = Processing correction Level PPP = WRS path RRR = WRS row YYYYMMDD = Acquisition year (YYYY) Month (MM) Day (DD) yyyymmdd = Processing year (yyyy) month (mm) day (dd) CC = Collection number TX = Collection category
PROCESSING_LEVEL	= “L1GS” = “L1GT” = “L1TP”	The identifier to inform the user of the processing level of the product.
COLLECTION_NUMBER	= NN	The product collection number.

Parameter Name	Value, Format, and Range	Parameter Description / Remarks
COLLECTION_CATEGORY	= “T1” = “T2” = “RT”	The scene collection category, “RT” for real-time, “T1” for Tier 1 quality, and “T2” for Tier 2 quality collection.
OUTPUT_FORMAT	= “GEOTIFF”	Output file format for image files.
FILE_NAME_BAND_1	= “LXSS_LLLL_PPPRRR_YYYYMMDD_yyyymmdd_CC_TX_B1.TIF”	The file name for L1 Band 1.
FILE_NAME_BAND_2	= “LXSS_LLLL_PPPRRR_YYYYMMDD_yyyymmdd_CC_TX_B2.TIF”	The file name for L1 Band 2.
FILE_NAME_BAND_3	= “LXSS_LLLL_PPPRRR_YYYYMMDD_yyyymmdd_CC_TX_B3.TIF”	The file name for L1 Band 3.
FILE_NAME_BAND_4	= “LXSS_LLLL_PPPRRR_YYYYMMDD_yyyymmdd_CC_TX_B4.TIF”	The file name for L1 Band 4.
FILE_NAME_BAND_5	= “LXSS_LLLL_PPPRRR_YYYYMMDD_yyyymmdd_CC_TX_B5.TIF”	The file name for L1 Band 5.
FILE_NAME_BAND_6_VCID_1	= “LXSS_LLLL_PPPRRR_YYYYMMDD_yyyymmdd_CC_TX_B6_VCID_1.TIF”	The file name for L1 Band 6 VCID 1.
FILE_NAME_BAND_6_VCID_2	= “LXSS_LLLL_PPPRRR_YYYYMMDD_yyyymmdd_CC_TX_B6_VCID_2.TIF”	The file name for L1 Band 6 VCID 2.
FILE_NAME_BAND_7	= “LXSS_LLLL_PPPRRR_YYYYMMDD_yyyymmdd_CC_TX_B7.TIF”	The file name for L1 Band 7.

Parameter Name	Value, Format, and Range	Parameter Description / Remarks
FILE_NAME_BAND_8	= “LXSS_LLLL_PPPRRR_YYYYMMDD_yyyymmdd_CC_TX_B8.TIF”	The file name for L1 Band 8.
FILE_NAME_QUALITY_L1_PIXEL	= “LXSS_LLLL_PPPRRR_YYYYMMDD_yyyymmdd_CC_TX_QA_PIXEL.TIF”	The file name for the L1 Quality Assessment (QA) Band.
FILE_NAME_QUALITY_L1_RADIOMETRIC_SATURATION	= “LXSS_LLLL_PPPRRR_YYYYMMDD_yyyymmdd_CC_TX_QA_RADSAT.TIF”	The file name for the Radiometric Saturation Quality Assessment (QA) Band.
FILE_NAME_GROUND_CONTROL_POINT	= “LXSS_LLLL_PPPRRR_YYYYMMDD_yyyymmdd_CC_TX_GCP.txt”	L1-generated external element file name for the GCP, if part of the product.
FILE_NAME_ANGLE_COEFFICIENT	= “LXSS_LLLL_PPPRRR_YYYYMMDD_yyyymmdd_CC_TX_ANG.txt”	The file name for the angle coefficient file.
FILE_NAME_ANGLE_SENSOR_AZIMUTH_BAND_4	= “LXSS_LLLL_PPPRRR_YYYYMMDD_yyyymmdd_CC_TX_VAA.TIF”	The file name for the Band 4 View (sensor) Azimuth Angle.
FILE_NAME_ANGLE_SENSOR_ZENITH_BAND_4	= “LXSS_LLLL_PPPRRR_YYYYMMDD_yyyymmdd_CC_TX_VZA.TIF”	The file name for the Band 4 View (sensor) Zenith Angle.
FILE_NAME_ANGLE_SOLAR_AZIMUTH_BAND_4	= “LXSS_LLLL_PPPRRR_YYYYMMDD_yyyymmdd_CC_TX_SAA.TIF”	The file name for the Band 4 Solar Azimuth Angle.
FILE_NAME_ANGLE_SOLAR_ZENITH_BAND_4	= “LXSS_LLLL_PPPRRR_YYYYMMDD_yyyymmdd_CC_TX_SZA.TIF”	The file name for the Band 4 Solar Zenith Angle.
FILE_NAME_METADATA_ODL	= “LXSS_LLLL_PPPRRR_YYYYMMDD_yyyymmdd_CC_TX_MTL.txt”	The file name for L1 ODL metadata.

Parameter Name	Value, Format, and Range	Parameter Description / Remarks
FILE_NAME_METADATA_XML	= “LXSS_LLLL_PPPRRR_YYYYMMDD_yyyymmdd_CC_TX_MTL.xml”	The file name for L1 XML metadata.
DATA_TYPE_BAND_1	= “UINT8”	The GeoTIFF file for band 1 uses unsigned 8-bit integers.
DATA_TYPE_BAND_2	= “UINT8”	The GeoTIFF file for band 2 uses unsigned 8-bit integers.
DATA_TYPE_BAND_3	= “UINT8”	The GeoTIFF file for band 3 uses unsigned 8-bit integers.
DATA_TYPE_BAND_4	= “UINT8”	The GeoTIFF file for band 4 uses unsigned 8-bit integers.
DATA_TYPE_BAND_5	= “UINT8”	The GeoTIFF file for band 5 uses unsigned 8-bit integers.
DATA_TYPE_BAND_6_VCID_1	= “UINT8”	The GeoTIFF file for band 6_VCID_1 uses unsigned 8-bit integers.
DATA_TYPE_BAND_6_VCID_2	= “UINT8”	The GeoTIFF file for band 6_VCID_2 uses unsigned 8-bit integers.
DATA_TYPE_BAND_7	= “UINT8”	The GeoTIFF file for band 7 uses unsigned 8-bit integers.
DATA_TYPE_BAND_8	= “UINT8”	The GeoTIFF file for band 8 uses unsigned 8-bit integers.
DATA_TYPE_QUALITY_L1_PIXEL	= “UINT16”	The L1 QA Band uses unsigned 16-bit integers.
DATA_TYPE_QUALITY_L1_RADIOMETRIC_SATURATION	= “UINT16”	The L1 radiometric saturation QA Band uses unsigned 16-bit integers.
DATA_TYPE_ANGLE_SENSOR_AZIMUTH_BAND_4	= “INT16”	The sensor azimuth angle band uses signed 16-bit integers.
DATA_TYPE_ANGLE_SENSOR_ZENITH_BAND_4	= “INT16”	The sensor zenith angle band uses signed 16-bit integers.
DATA_TYPE_ANGLE_SOLAR_AZIMUTH_BAND_4	= “INT16”	The solar azimuth angle band uses signed 16-bit integers.

Parameter Name	Value, Format, and Range	Parameter Description / Remarks
DATA_TYPE_ANGLE_SOLAR_ZENITH_BAND_4	= “INT16”	The solar zenith angle band uses signed 16-bit integers.
END_GROUP	= PRODUCT_CONTENTS	
GROUP	= IMAGE_ATTRIBUTES	
SPACECRAFT_ID	= “LANDSAT_7”	Spacecraft from which the data were captured.
SENSOR_ID	= “ETM”	Sensor(s) used to capture this scene.
WRS_TYPE	= 2	World Reference System (WRS) type used for the collection of this scene.
WRS_PATH	= 1-233	WRS-defined nominal Landsat satellite track (path) (orbital).
WRS_ROW	= 1-248	WRS-defined nominal Landsat satellite row, based on the latitudinal center frame of a Landsat image (orbital). The value is the row of the first full or partial scene in the product.
DATE_ACQUIRED	= YYYY-MM-DD	The date the image was acquired.
SCENE_CENTER_TIME	= “HH:MI:SS.SSSSSSSZ”	Scene center time and date for when the image was acquired. HH = Hour (00-23), MI = Minute, SS.SSSSSSS = Fractional seconds, Z = constant (indicates “Zulu” time (same as GMT)).
STATION_ID	= “XXX”	The Ground Station that received the data. See LSDS-547 Landsat Ground Station (GS) Identifiers for all possible station IDs (e.g., “LGN” = Landsat Ground Network).
CLOUD_COVER	= 0.00–100.00, -1	The overall cloud coverage (percent) of the WRS-2 scene. -1 indicates that the score was not calculated.

Parameter Name	Value, Format, and Range	Parameter Description / Remarks
CLOUD_COVER_LAND	= 0.00–100.00, -1	The overall cloud coverage over land (percent) in the WRS-2 scene. -1 indicates that the score was not calculated.
IMAGE_QUALITY	= 0-9, -1	Composite image quality for the bands. Values: 9 = Best. 0 = Worst. -1 = Image quality not calculated or assessed.
SATURATION_BAND_1	= “Y” = “N”	Indicates Band 1 includes saturated pixels identified by the Radiometric Saturation Quality Assessment (QA) Band.
SATURATION_BAND_2	= “Y” = “N”	Indicates Band 2 includes saturated pixels identified by the Radiometric Saturation QA Band.
SATURATION_BAND_3	= “Y” = “N”	Indicates Band 3 includes saturated pixels identified by the Radiometric Saturation QA Band.
SATURATION_BAND_4	= “Y” = “N”	Indicates Band 4 includes saturated pixels identified by the Radiometric Saturation QA Band.
SATURATION_BAND_5	= “Y” = “N”	Indicates Band 5 includes saturated pixels identified by the Radiometric Saturation QA Band.
SATURATION_BAND_6_VCID_1	= “Y” = “N”	Indicates Band 6 VCID 1 includes saturated pixels identified by the Radiometric Saturation QA Band.
SATURATION_BAND_6_VCID_2	= “Y” = “N”	Indicates Band 6 VCID 2 includes saturated pixels identified by the Radiometric Saturation QA Band.

Parameter Name	Value, Format, and Range	Parameter Description / Remarks
SATURATION_BAND_7	= “Y” = “N”	Indicates Band 7 includes saturated pixels identified by the Radiometric Saturation QA Band.
SATURATION_BAND_8	= “N”	Band 8 is not checked for saturation.
SUN_AZIMUTH	= -180.00000000 through 180.00000000	The Sun azimuth angle in degrees for the image center location at the image center acquisition time. 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.
SUN_ELEVATION	= -90.00000000 through 90.00000000	The Sun elevation angle in degrees for the image center location at the image center acquisition time. A positive value indicates a daytime scene. A negative value (-) indicates a nighttime scene. Note: For reflectance calculation, the sun zenith angle is needed, which is 90 - sun elevation angle.
EARTH_SUN_DISTANCE	= N.NNNNNNN	Measurement of the earth to sun distance at the particular day and time of imagery acquisition. Astronomical Unit (AU) of measurement.
SENSOR_MODE	= “SAM” = “BUMPER”	Scan Angle Monitor (SAM) Mode and Bumper (BUMPER) Mode.
SENSOR_MODE_SLC	= “ON” = “OFF”	Indicates whether the Scan Line Corrector (SLC) was ON, as during the first part of the mission. Or whether the SLC was OFF, as during the rest of the mission. When SLC is

Parameter Name	Value, Format, and Range	Parameter Description / Remarks
		OFF the line of sight traces a zig-zag pattern across the ground path.
SENSOR_ANOMALIES	= “SHUTTER_INTRUSION” = “NONE”	Indicates if shutter intrusion is found within scene.
END_GROUP	= IMAGE_ATTRIBUTES	
GROUP	= PROJECTION_ATTRIBUTES	
MAP_PROJECTION	= “UTM” = “PS”	The map projection used in creating the image. Universal Transverse Mercator (UTM) or Polar Stereographic (PS).
DATUM	= “WGS84”	The datum used in creating the image.
ELLIPSOID	= “WGS84”	The ellipsoid used in creating the image.
UTM_ZONE	= 1 through 60	The value used to indicate the zone number. This parameter is only included for the UTM projection.
VERTICAL_LON_FROM_POLE	= -180.00000 through +180.00000	Vertical longitude (decimal degrees) from the pole. Only present when MAP_PROJECTION is PS.
TRUE_SCALE_LAT	= -90.00000 through +90.00000	Latitude of true scale in a map projection. Only present when MAP_PROJECTION is PS.
FALSE_EASTING	= -100000000 through +100000000	Value added to all "x" values in the rectangular coordinates for a map projection. Frequently assigned to eliminate negative numbers. Expressed in the unit of measure identified in the ProjLinearUnitsGeoKey. Only present when MAP_PROJECTION is PS.
FALSE_NORTHING	= -100000000 through +100000000	Value added to all "y" values in the rectangular coordinates for a map

Parameter Name	Value, Format, and Range	Parameter Description / Remarks
		projection. Frequently assigned to eliminate negative numbers. Expressed in the unit of measure identified in the ProjLinearUnitsGeoKey. Only present when MAP_PROJECTION is PS.
GRID_CELL_SIZE_PANCHROMATIC	= 15.00	The grid cell size in meters used in creating the image for the panchromatic band.
GRID_CELL_SIZE_REFLECTIVE	= 30.00	The grid cell size in meters used in creating the image for Visible and Near Infrared (VNIR) / Short-Wave Infrared (SWIR) bands.
GRID_CELL_SIZE_THERMAL	= 30.00	The grid cell size in meters used in creating the image for the thermal bands.
PANCHROMATIC_LINES	= 0–99999	The number of product lines for the panchromatic band (Band 8).
PANCHROMATIC_SAMPLES	= 0–99999	The number of product samples for the panchromatic band (Band 8).
REFLECTIVE_LINES	= 0–99999	Product lines for the reflective bands.
REFLECTIVE_SAMPLES	= 0–99999	Product samples for the reflective bands.
THERMAL_LINES	= 0–99999	Product lines for the thermal bands.
THERMAL_SAMPLES	= 0–99999	Product samples for the thermal bands.
ORIENTATION	= “NORTH_UP”	The orientation used in creating the image.
CORNER_UL_LAT_PRODUCT	= -90.00000 through +90.00000	The latitude value for the upper-left corner of the product, measured at the center of the pixel. A positive (+) value indicates north latitude; a negative

Parameter Name	Value, Format, and Range	Parameter Description / Remarks
		(-) value indicates south latitude. Units are in degrees.
CORNER_UL_LON_PRODUCT	= -180.00000 through +180.00000	The longitude value for the upper-left corner of the product, measured at the center of the pixel. Positive (+) value indicates east longitude; negative (-) value indicates west longitude. Units are in degrees.
CORNER_UR_LAT_PRODUCT	= -90.00000 through +90.00000	The latitude value for the upper-right corner of the product, measured at the center of the pixel. Units are in degrees.
CORNER_UR_LON_PRODUCT	= -180.00000 through +180.00000	The longitude value for the upper-right corner of the product, measured at the center of the pixel. Units are in degrees.
CORNER_LL_LAT_PRODUCT	= -90.00000 through +90.00000	The latitude value for the lower-left corner of the product, measured at the center of the pixel. Units are in degrees.
CORNER_LL_LON_PRODUCT	= -180.00000 through +180.00000	The longitude value for the lower-left corner of the product, measured at the center of the pixel. Units are in degrees.
CORNER_LR_LAT_PRODUCT	= -90.00000 through +90.00000	The latitude value for the lower-right corner of the product, measured at the center of the pixel. Units are in degrees.
CORNER_LR_LON_PRODUCT	= -180.00000 through +180.00000	The longitude value for the lower-right corner of the product, measured at the center of the pixel. Units are in degrees.

Parameter Name	Value, Format, and Range	Parameter Description / Remarks
CORNER_UL_PROJECTION_X_PRODUCT	= -132000000.000 through 132000000.000	The upper-left corner map projection X coordinate, measured at the center of the pixel. Units are in meters.
CORNER_UL_PROJECTION_Y_PRODUCT	= -132000000.000 through 132000000.000	The upper-left corner map projection Y coordinate, measured at the center of the pixel. Units are in meters.
CORNER_UR_PROJECTION_X_PRODUCT	= -132000000.000 through 132000000.000	The upper-right corner map projection X coordinate, measured at the center of the pixel. Units are in meters.
CORNER_UR_PROJECTION_Y_PRODUCT	= -132000000.000 through 132000000.000	The upper-right corner map projection Y coordinate, measured at the center of the pixel. Units are in meters.
CORNER_LL_PROJECTION_X_PRODUCT	= -132000000.000 through 132000000.000	The lower-left corner map projection X coordinate, measured at the center of the pixel. Units are in meters.
CORNER_LL_PROJECTION_Y_PRODUCT	= -132000000.000 through 132000000.000	The lower-left corner map projection Y coordinate, measured at the center of the pixel. Units are in meters.
CORNER_LR_PROJECTION_X_PRODUCT	= -132000000.000 through 132000000.000	The lower-right corner map projection X coordinate, measured at the center of the pixel. Units are in meters.
CORNER_LR_PROJECTION_Y_PRODUCT	= -132000000.000 through 132000000.000	The lower-right corner map projection Y coordinate, measured at the center of the pixel. Units are in meters.
END_GROUP	= PROJECTION_ATTRIBUTES	
GROUP	= LEVEL1_PROCESSING_RECORD	
ORIGIN	= “Image courtesy of the U.S. Geological Survey”	Origin of the product.
DIGITAL_OBJECT_IDENTIFIER	= “https://doi.org/10.5066/P9TU80IG”	Digital Object Identifier for Level 1 ETM+. For more information on Digital Object Identifiers, visit https://www.doi.org.

Parameter Name	Value, Format, and Range	Parameter Description / Remarks
REQUEST_ID	= “NNNNNNNNNNNNN_UUUUU”	USGS products use the “NNNYYMMDDSSSS_UUUUU” format, where: NNNYYMMDDSSSS = 13-digit Tracking, Recording, and Metrics (TRAM) order number NNN = Node indicator YY = Year MM = Month DD = Day SSSS = Sequence number for the day UUUUU = Five-digit TRAM unit number
LANDSAT_SCENE_ID	= “LsSppprrrYYYYDDDGGGVV”	The unique Landsat scene identifier.
LANDSAT_PRODUCT_ID	= “LXSS_LLLL_PPPRRR_YYYYMMDD_yyyymmdd_CC_TX”	Landsat uses the “LXSS_LLLL_PPPRRR_YYYYMMDD_yyyymmdd_CC_TX” format, where: L = Landsat X = Sensor SS = Satellite (07) LLLL = Processing correction Level PPP = WRS path RRR = WRS row YYYYMMDD = Acquisition year (YYYY) Month (MM) Day (DD) yyyymmdd = Processing year (yyyy) month (mm) day (dd) CC = Collection number TX = Collection category
PROCESSING_LEVEL	= “L1GS” = “L1GT” = “L1TP”	The identifier to inform the user of the processing level of the product.

Parameter Name	Value, Format, and Range	Parameter Description / Remarks
COLLECTION_CATEGORY	= “T1” = “T2” = “RT”	The scene collection category, “RT” for real-time, “T1” for Tier 1 quality, and “T2” for Tier 2 quality collection.
OUTPUT_FORMAT	= “GEOTIFF”	Output file format for image files.
DATE_PRODUCT_GENERATED	= YYYY-MM-DDTHH:MI:SSZ	The date when the metadata file for the product was created: YYYY-MM-DDTHH:MI:SSZ Where: YYYY = Four-digit Julian year MM = Month of the Julian year (01-12) DD = Day of the Julian month (01-31) T = Start of time information in ODL American Standard Code for Information Interchange (ASCII) time code format HH = Hours (00-23) MI = Minutes (00-59) SS = Seconds (00-59) Z = Zulu time (same as Greenwich Mean Time (GMT))
PROCESSING_SOFTWARE_VERSION	= “LPGS_X.Y.Z”	The processing software version that created the product. The version consists of a system name followed by an underscore and then the software version, where X is the major release number, Y is the minor release number, and Z is the patch (or engineering) release number. X, Y, and Z are all numeric values.
FILE_NAME_BAND_1	= “LXSS_LLLL_PPPRRR_YYYYMMDD_yyyymmdd_CC_TX_B1.TIF”	The file name for L1 Band 1.

Parameter Name	Value, Format, and Range	Parameter Description / Remarks
FILE_NAME_BAND_2	= “LXSS_LLLL_PPPRRR_YYYYMMDD_yyyymmdd_CC_TX_B2.TIF”	The file name for L1 Band 2.
FILE_NAME_BAND_3	= “LXSS_LLLL_PPPRRR_YYYYMMDD_yyyymmdd_CC_TX_B3.TIF”	The file name for L1 Band 3.
FILE_NAME_BAND_4	= “LXSS_LLLL_PPPRRR_YYYYMMDD_yyyymmdd_CC_TX_B4.TIF”	The file name for L1 Band 4.
FILE_NAME_BAND_5	= “LXSS_LLLL_PPPRRR_YYYYMMDD_yyyymmdd_CC_TX_B5.TIF”	The file name for L1 Band 5.
FILE_NAME_BAND_6_VCID_1	= “LXSS_LLLL_PPPRRR_YYYYMMDD_yyyymmdd_CC_TX_B6_VCID_1.TIF	The file name for L1 Band 6 VCID 1.
FILE_NAME_BAND_6_VCID_2	= “LXSS_LLLL_PPPRRR_YYYYMMDD_yyyymmdd_CC_TX_B6_VCID_2.TIF”	The file name for L1 Band 6 VCID 2.
FILE_NAME_BAND_7	= “LXSS_LLLL_PPPRRR_YYYYMMDD_yyyymmdd_CC_TX_B7.TIF”	The file name for L1 Band 7.
FILE_NAME_BAND_8	= “LXSS_LLLL_PPPRRR_YYYYMMDD_yyyymmdd_CC_TX_B8.TIF”	The file name for L1 Band 8.
FILE_NAME_QUALITY_L1_PIXEL	= “LXSS_LLLL_PPPRRR_YYYYMMDD_yyyymmdd_CC_TX_QA_PIXEL.TIF”	The file name for the L1 Quality Assessment (QA) Band.
FILE_NAME_QUALITY_L1_RADIOMETRIC_SATURATION	= “LXSS_LLLL_PPPRRR_YYYYMMDD_yyyymmdd_CC_TX_QA_RADSAT.TIF”	The file name for the Radiometric Saturation Quality Assessment (QA) Band.

Parameter Name	Value, Format, and Range	Parameter Description / Remarks
FILE_NAME_GROUND_CONTROL_POINT	= “LXSS_LLLL_PPPRRR_YYYYMMDD_yyyymmdd_CC_TX_GCP.txt”	L1-generated external element file name for the GCP, if part of the product.
FILE_NAME_ANGLE_COEFFICIENT	= “LXSS_LLLL_PPPRRR_YYYYMMDD_yyyymmdd_CC_TX_ANG.txt”	The file name for the angle coefficient file.
FILE_NAME_ANGLE_SENSOR_AZIMUTH_BAND_4	= “LXSS_LLLL_PPPRRR_YYYYMMDD_yyyymmdd_CC_TX_VAA.TIF”	The file name for the Band 4 View (sensor) Azimuth Angle.
FILE_NAME_ANGLE_SENSOR_ZENITH_BAND_4	= “LXSS_LLLL_PPPRRR_YYYYMMDD_yyyymmdd_CC_TX_VZA.TIF”	The file name for the Band 4 View (sensor) Zenith Angle.
FILE_NAME_ANGLE_SOLAR_AZIMUTH_BAND_4	= “LXSS_LLLL_PPPRRR_YYYYMMDD_yyyymmdd_CC_TX_SAA.TIF”	The file name for the Band 4 Solar Azimuth Angle.
FILE_NAME_ANGLE_SOLAR_ZENITH_BAND_4	= “LXSS_LLLL_PPPRRR_YYYYMMDD_yyyymmdd_CC_TX_SZA.TIF”	The file name for the Band 4 Solar Zenith Angle.
FILE_NAME_METADATA_ODL	= “LXSS_LLLL_PPPRRR_YYYYMMDD_yyyymmdd_CC_TX_MTL.txt”	The file name for L1 ODL metadata.
FILE_NAME_METADATA_XML	= “LXSS_LLLL_PPPRRR_YYYYMMDD_yyyymmdd_CC_TX_MTL.xml”	The file name for L1 XML metadata.
FILE_NAME_CPF	= “LXSSCPF_YYYYMMDD_yyyymmdd_CC.NN”	The file name for the CPF used to generate the product.
DATA_SOURCE_ELEVATION	= “NED” = “RAMP” = “SRTM1” = “SRTM3”	Identifies the digital elevation data set used to terrain correct the product. **Included for L1GT and L1TP products.

Parameter Name	Value, Format, and Range	Parameter Description / Remarks
	= “GTOPO30” = “GLS2000”	
GROUND_CONTROL_POINTS_VERSION	= 0-999	GCP dataset version used in the precision correction process. This parameter is only present if the PROCESSING_LEVEL is L1TP.
GROUND_CONTROL_POINTS_MODEL	= 0-9999	Number of GCPs used in the precision correction process. This parameter is only present if the PROCESSING_LEVEL is L1TP.
GEOMETRIC_RMSE_MODEL	= 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. This parameter is only present if the PROCESSING_LEVEL is L1TP.
GEOMETRIC_RMSE_MODEL_Y	= 0.000 – 9999.999	The post-fit RMSE for the along-track direction. Units are in meters equal to or greater than zero, with no upper limit, and three decimal places. This parameter is only present if the PROCESSING_LEVEL is L1TP.
GEOMETRIC_RMSE_MODEL_X	= 0.000 – 9999.999	The post-fit RMSE for the along-track direction. Units are in meters equal to or greater than zero, with no upper limit, and three decimal places. This parameter is only present if the PROCESSING_LEVEL is L1TP.
EPHEMERIS_TYPE	= “DEFINITIVE” = “PREDICTIVE”	Identifier to inform the user of the orbital ephemeris type used. If the

Parameter Name	Value, Format, and Range	Parameter Description / Remarks
		field is not present, the user should assume PREDICTIVE in all cases.
DATE_ACQUIRED_GAP_FILL	= (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	= LEVEL1_PROCESSING_RECORD	
GROUP	= LEVEL1_MIN_MAX_RADIANCE	
RADIANCE_MAXIMUM_BAND_1	= 0.000 – 999.999	Maximum achievable spectral radiance value for Band 1.
RADIANCE_MINIMUM_BAND_1	= -999.999 through +999.999	Minimum achievable spectral radiance value for Band 1.
RADIANCE_MAXIMUM_BAND_2	= 0.000 – 999.999	Maximum achievable spectral radiance value for Band 2.
RADIANCE_MINIMUM_BAND_2	= -999.999 through +999.999	Minimum achievable spectral radiance value for Band 2.
RADIANCE_MAXIMUM_BAND_3	= 0.000 – 999.999	Maximum achievable spectral radiance value for Band 3.
RADIANCE_MINIMUM_BAND_3	= -999.999 through +999.999	Minimum achievable spectral radiance value for Band 3.
RADIANCE_MAXIMUM_BAND_4	= 0.000 – 999.999	Maximum achievable spectral radiance value for Band 4.
RADIANCE_MINIMUM_BAND_4	= -999.999 through +999.999	Minimum achievable spectral radiance value for Band 4.
RADIANCE_MAXIMUM_BAND_5	= 0.000 – 999.999	Maximum achievable spectral radiance value for Band 5.
RADIANCE_MINIMUM_BAND_5	= -999.999 through +999.999	Minimum achievable spectral radiance value for Band 5.

Parameter Name	Value, Format, and Range	Parameter Description / Remarks
RADIANCE_MAXIMUM_BAND_6_VCID_1	= 0.000 – 999.999	Maximum achievable spectral radiance value for Band 6 VCID 1.
RADIANCE_MINIMUM_BAND_6_VCID_1	= -999.999 through +999.999	Minimum achievable spectral radiance value for Band 6 VCID 1.
RADIANCE_MAXIMUM_BAND_6_VCID_2	= 0.000 – 999.999	Maximum achievable spectral radiance value for Band 6 VCID 2.
RADIANCE_MINIMUM_BAND_6_VCID_2	= -999.999 through +999.999	Minimum achievable spectral radiance value for Band 6 VCID 2.
RADIANCE_MAXIMUM_BAND_7	= 0.000 – 999.999	Maximum achievable spectral radiance value for Band 7.
RADIANCE_MINIMUM_BAND_7	= -999.999 through +999.999	Minimum achievable spectral radiance value for Band 7.
RADIANCE_MAXIMUM_BAND_8	= 0.000 – 999.999	Maximum achievable spectral radiance value for Band 8.
RADIANCE_MINIMUM_BAND_8	= -999.999 through +999.999	Minimum achievable spectral radiance value for Band 8.
END_GROUP	= LEVEL1_MIN_MAX_RADIANCE	
GROUP	= LEVEL1_MIN_MAX_REFLECTANCE	
REFLECTANCE_MAXIMUM_BAND_1	= 0.000000 through 2.000000	Maximum achievable reflectance value for Band 1.
REFLECTANCE_MINIMUM_BAND_1	= -1.000000 through 2.000000	Minimum achievable reflectance value for Band 1.
REFLECTANCE_MAXIMUM_BAND_2	= 0.000000 through 2.000000	Maximum achievable reflectance value for Band 2.
REFLECTANCE_MINIMUM_BAND_2	= -1.000000 through 2.000000	Minimum achievable reflectance value for Band 2.
REFLECTANCE_MAXIMUM_BAND_3	= 0.000000 through 2.000000	Maximum achievable reflectance value for Band 3.
REFLECTANCE_MINIMUM_BAND_3	= -1.000000 through 2.000000	Minimum achievable reflectance value for Band 3.

Parameter Name	Value, Format, and Range	Parameter Description / Remarks
REFLECTANCE_MAXIMUM_BAND_4	= 0.000000 through 2.000000	Maximum achievable reflectance value for Band 4.
REFLECTANCE_MINIMUM_BAND_4	= -1.000000 through 2.000000	Minimum achievable reflectance value for Band 4.
REFLECTANCE_MAXIMUM_BAND_5	= 0.000000 through 2.000000	Maximum achievable reflectance value for Band 5.
REFLECTANCE_MINIMUM_BAND_5	= -1.000000 through 2.000000	Minimum achievable reflectance value for Band 5.
REFLECTANCE_MAXIMUM_BAND_7	= 0.000000 through 2.000000	Maximum achievable reflectance value for Band 7.
REFLECTANCE_MINIMUM_BAND_7	= -1.000000 through 2.000000	Minimum achievable reflectance value for Band 7.
REFLECTANCE_MAXIMUM_BAND_8	= 0.000000 through 2.000000	Maximum achievable reflectance value for Band 8.
REFLECTANCE_MINIMUM_BAND_8	= -1.000000 through 2.000000	Minimum achievable reflectance value for Band 8.
END_GROUP	= LEVEL1_MIN_MAX_REFLECTANCE	
GROUP	= LEVEL1_MIN_MAX_PIXEL_VALUE	
QUANTIZE_CAL_MAX_BAND_1	= 0 - 255	Maximum possible pixel value for Band 1.
QUANTIZE_CAL_MIN_BAND_1	= 0 - 1	Minimum possible pixel value for Band 1.
QUANTIZE_CAL_MAX_BAND_2	= 0 - 255	Maximum possible pixel value for Band 2.
QUANTIZE_CAL_MIN_BAND_2	= 0 - 1	Minimum possible pixel value for Band 2.
QUANTIZE_CAL_MAX_BAND_3	= 0 - 255	Maximum possible pixel value for Band 3.
QUANTIZE_CAL_MIN_BAND_3	= 0 - 1	Minimum possible pixel value for Band 3.

Parameter Name	Value, Format, and Range	Parameter Description / Remarks
QUANTIZE_CAL_MAX_BAND_4	= 0 - 255	Maximum possible pixel value for Band 4.
QUANTIZE_CAL_MIN_BAND_4	= 0 - 1	Minimum possible pixel value for Band 4.
QUANTIZE_CAL_MAX_BAND_5	= 0 - 255	Maximum possible pixel value for Band 5.
QUANTIZE_CAL_MIN_BAND_5	= 0 - 1	Minimum possible pixel value for Band 5.
QUANTIZE_CAL_MAX_BAND_6_VCID_1	= 0 - 255	Maximum possible pixel value for Band 6 VCID 1.
QUANTIZE_CAL_MIN_BAND_6_VCID_1	= 0 - 1	Minimum possible pixel value for Band 6 VCID 1.
QUANTIZE_CAL_MAX_BAND_6_VCID_2	= 0 - 255	Maximum possible pixel value for Band 6 VCID 2.
QUANTIZE_CAL_MIN_BAND_6_VCID_2	= 0 - 1	Minimum possible pixel value for Band 6 VCID 2.
QUANTIZE_CAL_MAX_BAND_7	= 0 - 255	Maximum possible pixel value for Band 7.
QUANTIZE_CAL_MIN_BAND_7	= 0 - 1	Minimum possible pixel value for Band 7.
QUANTIZE_CAL_MAX_BAND_8	= 0 - 255	Maximum possible pixel value for Band 8.
QUANTIZE_CAL_MIN_BAND_8	= 0 - 1	Minimum possible pixel value for Band 8.
END_GROUP	= LEVEL1_MIN_MAX_PIXEL_VALUE	
GROUP	= LEVEL1_RADIOMETRIC_RESCALING	
RADIANCE_MULT_BAND_1	= N.NNNNE-NN	The multiplicative rescaling factor used to convert calibrated DN to

Parameter Name	Value, Format, and Range	Parameter Description / Remarks
		Radiance units for Band 1 (W/(m^2 sr um)/DN).
RADIANCE_MULT_BAND_2	= N.NNNNE-NN	The multiplicative rescaling factor used to convert calibrated DN to Radiance units for Band 2 (W/(m^2 sr um)/DN).
RADIANCE_MULT_BAND_3	= N.NNNNE-NN	The multiplicative rescaling factor used to convert calibrated DN to Radiance units for Band 3 (W/(m^2 sr um)/DN).
RADIANCE_MULT_BAND_4	= N.NNNNE-NN	The multiplicative rescaling factor used to convert calibrated DN to Radiance units for Band 4 (W/(m^2 sr um)/DN).
RADIANCE_MULT_BAND_5	= N.NNNNE-NN	The multiplicative rescaling factor used to convert calibrated DN to Radiance units for Band 5 (W/(m^2 sr um)/DN).
RADIANCE_MULT_BAND_6_VCID_1	= N.NNNNE-NN	The multiplicative rescaling factor used to convert calibrated DN to Radiance units for Band 6 VCID 1 (W/(m^2 sr um)/DN).
RADIANCE_MULT_BAND_6_VCID_2	= N.NNNNE-NN	The multiplicative rescaling factor used to convert calibrated DN to Radiance units for Band 6 VCID 2 (W/(m^2 sr um)/DN).
RADIANCE_MULT_BAND_7	= N.NNNNE-NN	The multiplicative rescaling factor used to convert calibrated DN to Radiance units for Band 7 (W/(m^2 sr um)/DN).
RADIANCE_MULT_BAND_8	= N.NNNNE-NN	The multiplicative rescaling factor used to convert calibrated DN to

Parameter Name	Value, Format, and Range	Parameter Description / Remarks
		Radiance units for Band 8 (W/(m^2 sr um)/DN).
RADIANCE_ADD_BAND_1	= -9999.99999 through +9999.99999	The additive rescaling factor used to convert calibrated DN to Radiance units for Band 1 (W/(m^2 sr um)).
RADIANCE_ADD_BAND_2	= -9999.99999 through +9999.99999	The additive rescaling factor used to convert calibrated DN to Radiance units for Band 2 (W/(m^2 sr um).
RADIANCE_ADD_BAND_3	= -9999.99999 through +9999.99999	The additive rescaling factor used to convert calibrated DN to Radiance units for Band 3 (W/(m^2 sr um).
RADIANCE_ADD_BAND_4	= -9999.99999 through +9999.99999	The additive rescaling factor used to convert calibrated DN to Radiance units for Band 4 (W/(m^2 sr um).
RADIANCE_ADD_BAND_5	= -9999.99999 through +9999.99999	The additive rescaling factor used to convert calibrated DN to Radiance units for Band 5 (W/(m^2 sr um).
RADIANCE_ADD_BAND_6_VCID_1	= -9999.99999 through +9999.99999	The additive rescaling factor used to convert calibrated DN to Radiance units for Band 6 VCID 1 (W/(m^2 sr um).
RADIANCE_ADD_BAND_6_VCID_2	= -9999.99999 through +9999.99999	The additive rescaling factor used to convert calibrated DN to Radiance units for Band 6 VCID 2 (W/(m^2 sr um).
RADIANCE_ADD_BAND_7	= -9999.99999 through +9999.99999	The additive rescaling factor used to convert calibrated DN to Radiance units for Band 7 (W/(m^2 sr um).
RADIANCE_ADD_BAND_8	= -9999.99999 through +9999.99999	The additive rescaling factor used to convert calibrated DN to Radiance units for Band 8 (W/(m^2 sr um).

Parameter Name	Value, Format, and Range	Parameter Description / Remarks
REFLECTANCE_MULT_BAND_1	= N.NNNNE-NN	The multiplicative rescaling factor used to convert calibrated DN to Reflectance for Band 1 (DN^-1).
REFLECTANCE_MULT_BAND_2	= N.NNNNE-NN	The multiplicative rescaling factor used to convert calibrated DN to Reflectance for Band 2 (DN^-1).
REFLECTANCE_MULT_BAND_3	= N.NNNNE-NN	The multiplicative rescaling factor used to convert calibrated DN to Reflectance for Band 3 (DN^-1).
REFLECTANCE_MULT_BAND_4	= N.NNNNE-NN	The multiplicative rescaling factor used to convert calibrated DN to Reflectance for Band 4 (DN^-1).
REFLECTANCE_MULT_BAND_5	= N.NNNNE-NN	The multiplicative rescaling factor used to convert calibrated DN to Reflectance for Band 5 (DN^-1).
REFLECTANCE_MULT_BAND_7	= N.NNNNE-NN	The multiplicative rescaling factor used to convert calibrated DN to Reflectance for Band 7 (DN^-1).
REFLECTANCE_MULT_BAND_8	= N.NNNNE-NN	The multiplicative rescaling factor used to convert calibrated DN to Reflectance for Band 8 (DN^-1).
REFLECTANCE_ADD_BAND_1	= N.NNNNNN	The additive rescaling factor used to convert calibrated DN to Reflectance for Band 1.
REFLECTANCE_ADD_BAND_2	= N.NNNNNN	The additive rescaling factor used to convert calibrated DN to Reflectance for Band 2.
REFLECTANCE_ADD_BAND_3	= N.NNNNNN	The additive rescaling factor used to convert calibrated DN to Reflectance for Band 3.

Parameter Name	Value, Format, and Range	Parameter Description / Remarks
REFLECTANCE_ADD_BAND_4	= N.NNNNNN	The additive rescaling factor used to convert calibrated DN to Reflectance for Band 4.
REFLECTANCE_ADD_BAND_5	= N.NNNNNN	The additive rescaling factor used to convert calibrated DN to Reflectance for Band 5.
REFLECTANCE_ADD_BAND_7	= N.NNNNNN	The additive rescaling factor used to convert calibrated DN to Reflectance for Band 7.
REFLECTANCE_ADD_BAND_8	= N.NNNNNN	The additive rescaling factor used to convert calibrated DN to Reflectance for Band 8.
END_GROUP	= LEVEL1_RADIOMETRIC_RESCALING	
GROUP	= LEVEL1_THERMAL_CONSTANTS	
K1_CONSTANT_BAND_6_VCID_1	= NNNN.NN	Calibration constant for Band 6 radiance to temperature conversion.
K2_CONSTANT_BAND_6_VCID_1	= NNNN.NN	Calibration constant for Band 6 radiance to temperature conversion.
K1_CONSTANT_BAND_6_VCID_2	= NNNN.NN	Calibration constant for Band 6 radiance to temperature conversion.
K2_CONSTANT_BAND_6_VCID_2	= NNNN.NN	Calibration constant for Band 6 radiance to temperature conversion.
END_GROUP	= LEVEL1_THERMAL_CONSTANTS	
GROUP	= LEVEL1_PROJECTION_PARAMETERS	
MAP_PROJECTION	= “UTM” = “PS”	The map projection used in creating the image. Universal Transverse Mercator (UTM) or Polar Stereographic (PS).

Parameter Name	Value, Format, and Range	Parameter Description / Remarks
DATUM	= “WGS84”	The datum used in creating the image.
ELLIPSOID	= “WGS84”	The ellipsoid used in creating the image.
UTM_ZONE	= 1 through 60	The value used to indicate the zone number. This parameter is only included for the UTM projection.
VERTICAL_LON_FROM_POLE	= -180.00000 through +180.00000	Vertical longitude (decimal degrees) from the pole. Only present when MAP_PROJECTION is PS.
TRUE_SCALE_LAT	= -90.00000 through +90.00000	Latitude of true scale in a map projection. Only present when MAP_PROJECTION is PS.
FALSE_EASTING	= -100000000 through +100000000	Value added to all "x" values in the rectangular coordinates for a map projection. Frequently assigned to eliminate negative numbers. Expressed in the unit of measure identified in the ProjLinearUnitsGeoKey. Only present when MAP_PROJECTION is PS.
FALSE_NORTHING	= -100000000 through +100000000	Value added to all "y" values in the rectangular coordinates for a map projection. Frequently assigned to eliminate negative numbers. Expressed in the unit of measure identified in the ProjLinearUnitsGeoKey. Only present when MAP_PROJECTION is PS.
GRID_CELL_SIZE_PANCHROMATIC	= 15.00	The grid cell size in meters used in creating the image for the panchromatic band.

Parameter Name	Value, Format, and Range	Parameter Description / Remarks
GRID_CELL_SIZE_REFLECTIVE	= 30.00	The grid cell size in meters used in creating the image for Visible and Near Infrared (VNIR) / Short-Wave Infrared (SWIR) bands.
GRID_CELL_SIZE_THERMAL	= 30.00	The grid cell size in meters used in creating the image for the thermal bands.
ORIENTATION	= “NORTH_UP”	The orientation used in creating the image.
RESAMPLING_OPTION	= “CUBIC_CONVOLUTION”	The resampling option used in creating the image. Cubic Convolution (CC).
SCAN_GAP_INTERPOLATION	= 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	= LEVEL1_PROJECTION_PARAMETERS	
GROUP	= PRODUCT_PARAMETERS	Beginning of the product parameters group (both 1R and 1G products).
CORRECTION_GAIN_BAND_1	= “CPF” = “INTERNAL_CALIBRATION”	Correction method used by L1 in creating the image for Band 1.
CORRECTION_GAIN_BAND_2	= “CPF” = “INTERNAL_CALIBRATION”	Correction method used by L1 in creating the image for Band 2.
CORRECTION_GAIN_BAND_3	= “CPF” = “INTERNAL_CALIBRATION”	Correction method used by L1 in creating the image for Band 3.
CORRECTION_GAIN_BAND_4	= “CPF” = “INTERNAL_CALIBRATION”	Correction method used by L1 in creating the image for Band 4.
CORRECTION_GAIN_BAND_5	= “CPF” = “INTERNAL_CALIBRATION”	Correction method used by L1 in creating the image for Band 5.

Parameter Name	Value, Format, and Range	Parameter Description / Remarks
CORRECTION_GAIN_BAND_6_VCID_1	= “CPF” = “INTERNAL_CALIBRATION”	Correction method used by L1 in creating the image for Band 6 VCID 1.
CORRECTION_GAIN_BAND_6_VCID_2	= “CPF” = “INTERNAL_CALIBRATION”	Correction method used by L1 in creating the image for Band 6 VCID 2.
CORRECTION_GAIN_BAND_7	= “CPF” = “INTERNAL_CALIBRATION”	Correction method used by L1 in creating the image for Band 7.
CORRECTION_GAIN_BAND_8	= “CPF” = “INTERNAL_CALIBRATION”	Correction method used by L1 in creating the image for Band 8.
CORRECTION_BIAS_BAND_1	= “CPF” = “INTERNAL_CALIBRATION”	Bias correction method used by L1 in creating the image for Band 1.
CORRECTION_BIAS_BAND_2	= “CPF” = “INTERNAL_CALIBRATION”	Bias correction method used by L1 in creating the image for Band 2.
CORRECTION_BIAS_BAND_3	= “CPF” = “INTERNAL_CALIBRATION”	Bias correction method used by L1 in creating the image for Band 3.
CORRECTION_BIAS_BAND_4	= “CPF” = “INTERNAL_CALIBRATION”	Bias correction method used by L1 in creating the image for Band 4.
CORRECTION_BIAS_BAND_5	= “CPF” = “INTERNAL_CALIBRATION”	Bias correction method used by L1 in creating the image for Band 5.
CORRECTION_BIAS_BAND_6_VCID_1	= “CPF” = “INTERNAL_CALIBRATION”	Bias correction method used by L1 in creating the image for Band 6 VCID 1.
CORRECTION_BIAS_BAND_6_VCID_2	= “CPF” = “INTERNAL_CALIBRATION”	Bias correction method used by L1 in creating the image for Band 6 VCID 2.
CORRECTION_BIAS_BAND_7	= “CPF” = “INTERNAL_CALIBRATION”	Bias correction method used by L1 in creating the image for Band 7.
CORRECTION_BIAS_BAND_8	= “CPF” = “INTERNAL_CALIBRATION”	Bias correction method used by L1 in creating the image for Band 8.
GAIN_BAND_1	= “L” = “H”	Gain state for Band 1’s first data line.
GAIN_BAND_2	= “L” = “H”	Gain state for Band 2’s first data line.
GAIN_BAND_3	= “L” = “H”	Gain state for Band 3’s first data line.

Parameter Name	Value, Format, and Range	Parameter Description / Remarks
GAIN_BAND_4	= “L” = “H”	Gain state for Band 4’s first data line.
GAIN_BAND_5	= “L” = “H”	Gain state for Band 5’s first data line.
GAIN_BAND_6_VCID_1	= “L” = “H”	Gain state for Band 6-Format 1’s first data line.
GAIN_BAND_6_VCID_2	= “L” = “H”	Gain state for Band 6-Format 2’s first data line.
GAIN_BAND_7	= “L” = “H”	Gain state for Band 7’s first data line.
GAIN_BAND_8	= “L” = “H”	Gain state for Band 8’s first data line.
GAIN_CHANGE_BAND_1	= “HH” = “LL” = “LH” = “HL” = “U”	Presence and direction of gain change for Band 1. HH = no gain change LL = no gain change LH = low to high HL = high to low U = Unknown
GAIN_CHANGE_BAND_2	= “HH” = “LL” = “LH” = “HL” = “U”	Presence and direction of gain change for Band 2. HH = no gain change LL = no gain change LH = low to high HL = high to low U = Unknown
GAIN_CHANGE_BAND_3	= “HH” = “LL” = “LH”	Presence and direction of gain change for Band 3. HH = no gain change

Parameter Name	Value, Format, and Range	Parameter Description / Remarks
	= “HL” = “U”	LL = no gain change LH = low to high HL = high to low U = Unknown
GAIN_CHANGE_BAND_4	= “HH” = “LL” = “LH” = “HL” = “U”	Presence and direction of gain change for Band 4. HH = no gain change LL = no gain change LH = low to high HL = high to low U = Unknown
GAIN_CHANGE_BAND_5	= “HH” = “LL” = “LH” = “HL” = “U”	Presence and direction of gain change for Band 5. HH = no gain change LL = no gain change LH = low to high HL = high to low U = Unknown
GAIN_CHANGE_BAND_6_VCID_1	= “HH” = “LL” = “LH” = “HL” = “U”	Presence and direction of gain change for Band 6 Format 1. HH = no gain change LL = no gain change LH = low to high HL = high to low U = Unknown
GAIN_CHANGE_BAND_6_VCID_2	= “HH” = “LL” = “LH”	Presence and direction of gain change for Band 6 Format 2. HH = no gain change

Parameter Name	Value, Format, and Range	Parameter Description / Remarks
	= “HL” = “U”	LL = no gain change LH = low to high HL = high to low U = Unknown
GAIN_CHANGE_BAND_7	= “HH” = “LL” = “LH” = “HL” = “U”	Presence and direction of gain change for Band 7. HH = no gain change LL = no gain change LH = low to high HL = high to low U = Unknown
GAIN_CHANGE_BAND_8	= “HH” = “LL” = “LH” = “HL” = “U”	Presence and direction of gain change for Band 8. HH = no gain change LL = no gain change LH = low to high HL = high to low U = Unknown
GAIN_CHANGE_SCAN_BAND_1	= 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 occurred in the previous scan.
GAIN_CHANGE_SCAN_BAND_2	= 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 occurred in the previous scan.
GAIN_CHANGE_SCAN_BAND_3	= 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 occurred in the previous scan.

Parameter Name	Value, Format, and Range	Parameter Description / Remarks
GAIN_CHANGE_SCAN_BAND_4	= 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 occurred in the previous scan.
GAIN_CHANGE_SCAN_BAND_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 occurred in the previous scan.
GAIN_CHANGE_SCAN_BAND_6_VCID_1	= 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 occurred in the previous scan.
GAIN_CHANGE_SCAN_BAND_6_VCID_2	= 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 occurred in the previous scan.
GAIN_CHANGE_SCAN_BAND_7	= 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 occurred in the previous scan.
GAIN_CHANGE_SCAN_BAND_8	= 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 occurred in the previous scan.
END_GROUP	= PRODUCT_PARAMETERS	
END_GROUP	= LANDSAT_METADATA_FILE	
END		

Table 3-4. L1 Metadata ODL File

The XML metadata file and ODL metadata file have comparable fields. The LANDSAT_METADATA_FILE group for ODL is synonymous to the root element LANDSAT_METADATA_FILE for XML. The LANDSAT_METADATA_FILE group for ODL contains nested groups, synonymously, the LANDSAT_METADATA_FILE root element for XML has children elements. In the XML metadata file, the ODL parameter name is used in the start-tag and end-tag for elements. All parameters listed in the metadata file using ODL format are also in a separate metadata file using the XML format.

The XML metadata file and ODL metadata file have some contrasts. The ODL file distinguishes between strings and numerical values through the presence or absence of quotes around a value. The XML file does not make that distinction. The ODL file has an END statement signifying the end of the file. The XML file does not have a comparable entity.

XML Elements
<?xml version="1.0" encoding="UTF-8"?>
<LANDSAT_METADATA_FILE>
<PRODUCT_CONTENTS>
<ORIGIN>Image courtesy of the U.S. Geological Survey</ORIGIN>
<DIGITAL_OBJECT_IDENTIFIER>https://doi.org/10.5066/P9TU80IG</DIGITAL_OBJECT_IDENTIFIER>
<LANDSAT_PRODUCT_ID>LXSS_LLLL_PPPRRR_YYYYMMDD_yyyymmdd_CC_TX</LANDSAT_PRODUCT_ID>
<PROCESSING_LEVEL>L1GS</PROCESSING_LEVEL>
<COLLECTION_NUMBER>NN</COLLECTION_NUMBER>
<COLLECTION_CATEGORY>T1</COLLECTION_CATEGORY>
<OUTPUT_FORMAT>GEOTIFF</OUTPUT_FORMAT>
<FILE_NAME_BAND_1>LXSS_LLLL_PPPRRR_YYYYMMDD_yyyymmdd_CC_TX_B1.TIF</FILE_NAME_BAND_1>
<FILE_NAME_BAND_2>LXSS_LLLL_PPPRRR_YYYYMMDD_yyyymmdd_CC_TX_B2.TIF</FILE_NAME_BAND_2>
<FILE_NAME_BAND_3>LXSS_LLLL_PPPRRR_YYYYMMDD_yyyymmdd_CC_TX_B3.TIF</FILE_NAME_BAND_3>
<FILE_NAME_BAND_4>LXSS_LLLL_PPPRRR_YYYYMMDD_yyyymmdd_CC_TX_B4.TIF</FILE_NAME_BAND_4>
<FILE_NAME_BAND_5>LXSS_LLLL_PPPRRR_YYYYMMDD_yyyymmdd_CC_TX_B5.TIF</FILE_NAME_BAND_5>
<FILE_NAME_BAND_6_VCID_1>LXSS_LLLL_PPPRRR_YYYYMMDD_yyyymmdd_CC_TX_B6_VCID_1.TIF</FILE_NAME_BAND_6_VCID_1>
<FILE_NAME_BAND_6_VCID_2>LXSS_LLLL_PPPRRR_YYYYMMDD_yyyymmdd_CC_TX_B6_VCID_2.TIF</FILE_NAME_BAND_6_VCID_2>
<FILE_NAME_BAND_7>LXSS_LLLL_PPPRRR_YYYYMMDD_yyyymmdd_CC_TX_B7.TIF</FILE_NAME_BAND_7>
<FILE_NAME_BAND_8>LXSS_LLLL_PPPRRR_YYYYMMDD_yyyymmdd_CC_TX_B8.TIF</FILE_NAME_BAND_8>
<FILE_NAME_QUALITY_L1_PIXEL>LXSS_LLLL_PPPRRR_YYYYMMDD_yyyymmdd_CC_TX_QA_PIXEL.TIF</FILE_NAME_QUALITY_L1_PIXEL>
<FILE_NAME_QUALITY_L1_RADIOMETRIC_SATURATION>LXSS_LLLL_PPPRRR_YYYYMMDD_yyyymmdd_CC_TX_QA_RADSAT.TIF</FILE_NAME_QUALITY_L1_RADIOMETRIC_SATURATION>

XML Elements
<FILE_NAME_GROUND_CONTROL_POINT>LXSS_LLLL_PPPRRR_YYYYMMDD_yyyymmdd_CC_TX_GCP.txt</FILE_NAME_GROUND_CONTROL_POINT>
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Table 3-5. L1 Metadata XML File

3.6 L1 Angle Coefficients File

The L1 angle coefficients file contains metadata and coefficients that allow solar and satellite viewing angles, for all bands, to be calculated. Table 3-6 lists the full contents of the L1 angle coefficients file. The angle coefficients file is text in the ODL format. Refer to https://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	= “LE7ppprrrYYYYDDDGGGVV”	The unique Landsat scene identifier.
SPACECRAFT_ID	= “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	= 1 – 9	Number of bands contained in the angle coefficient file.
BAND_LIST	= (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.
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.

Parameter Name	Value, Format, and Range	Parameter Description / Remarks
PROJECTION_PARAMETERS	= (P_1 … P_{15})	GCTP map projection parameters array with 15 double precision floating point parameters. This is all zeros for UTM. PS 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.
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).

Parameter Name	Value, Format, and Range	Parameter Description / Remarks
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
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.

Parameter Name	Value, Format, and Range	Parameter Description / Remarks
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.
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.

Parameter Name	Value, Format, and Range	Parameter Description / Remarks
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.
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).

Parameter Name	Value, Format, and Range	Parameter Description / Remarks
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 3-6. Angle Coefficients File

3.7 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 Table 3-7.

3.8 Checksum File

A single checksum file is created for all the files in the product. The checksum file contains a Message-Digest Algorithm 5 (MD5) checksum for every file. The file is in plain text format and contains the output from md5sum for each file. The checksum file is not distributed with the final product.

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 3-7. Example GCP Output File

Section 4 Product Files

The product consists of individual files that are listed in Table 2-3. The files are unbundled and can be downloaded individually. L1 products are available for distribution via HTTPS download. The following provides information on the distribution method for the available L1 product formats.

4.1 Electronic Transfer

When data are ready for distribution, they are stored in directories on the production online cache for retrieval.

Appendix A Projection Parameters

This appendix contains the map projection parameters used in the USGS projection parameters (see 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.

Appendix B Acronyms

0R	Zero Reformatted Data
ANG	Angle Coefficient File
ASCII	American Standard Code for Information Interchange
AU	Astronomical Unit
C2	Collection 2
CC	Cubic Convolution
CCB	Configuration Control Board
CFMask	C version of FMask
COG	Cloud Optimized GeoTIFF
CPF	Calibration Parameter File
CR	Change Request
DEM	Digital Elevation Model
DFCB	Data Format Control Book
DN	Digital Number
DOI	Department of the Interior
DPAS	Data Processing and Archive System
ECEF	Earth Centered Earth Fixed
EPSG	European Petroleum Survey Group
EROS	Earth Resources Observation and Science
ESDIS	Earth Science Data and Information System
ETM+	Enhanced Thematic Mapper Plus
FT	File Type
GCP	Ground Control Point
GDAL	Geospatial Data Abstraction Library
GeoTIFF	Geographic Tagged Image File Format
GLS	Global Land Survey
GMT	Greenwich Mean Time
GS	Ground Station
GTOPO30	Global 30 Arc-Second Elevation Data Set
HDF	Hierarchical Data Format
HTTPS	Hypertext Transfer Protocol Secure
IAS	Image Assessment System
IC	Internal Calibrator
L0	Level 0
L0R	Level 0 Reformatted
L0Ra	Level 0 Reformatted Archive
L0Rp	Level 0 Reformatted Product
L1	Level 1 Data Product
L1GS	Level 1 Systematic (Corrected)
L1GT	Level 1 Systematic Terrain (Corrected)
L1R	Level 1 Radiometric (Corrected)

L1TP	Level 1 Terrain Precision (Corrected)
L7	Landsat 7
LAT	Latitude
LGN	Landsat Ground Network
LGS	Landsat Ground System
LON	Longitude
LPGS	Landsat Product Generation System
LPS	Landsat Processing System
LR	Lower Right
LSDS	Land Satellites Data System
m	Meter
Mbps	Megabits per second
MD5	Message-Digest Algorithm 5
MSCD	Mirror Scan Correction Data
MTL	Landsat Metadata
NUP	North Up
ODL	Object Description Language
OMA	Oblique Mercator Type A
OMB	Oblique Mercator Type B
PCD	Payload Correction Data
POSC	Petrotechnical Open Software Corporation
PS	Polar Stereographic
QA	Quality Assessment
RADSAT	Radiometric Saturation
RMSE	Root Mean Square Error
RPC	Rational Polynomial Coefficient
RT	Real Time
SAA	Solar Azimuth Angle
SAM	Scan Angle Monitor
SLC	Scan Line Corrector
SLO	Scan Line Offset
SR	Surface Reflectance
ST	Surface Temperature
SWIR	Short Wavelength Infrared
SZA	Solar Zenith Angle
T1	Tier 1
T2	Tier 2
TIFF	Tagged Image File Format
TOA	Top of Atmosphere
TRAM	Tracking, Routing, and Metrics
USGS	U.S. Geological Survey
UTF	Unicode Transformation Format
UTM	Universal Transverse Mercator

VAA	View Azimuth Angle
VCID	Virtual Channel Identifier
VNIR	Visible to Near Infrared
VZA	View Zenith Angle
WGS84	World Geodetic System 1984
WRS	Worldwide Reference System
WRS-2	Worldwide Reference System 2
XML	Extensible Markup Language

References

Please see https://www.usgs.gov/land-resources/nli/landsat/glossary-and-acronyms for a complete list of acronyms.

USGS/EROS. LSDS-31. Landsat 7 System Calibration Parameter File (CPF) Definition.

USGS/EROS. LSDS-270. Landsat 7 (L7) Enhanced Thematic Mapper Plus (ETM+) Level 0 Reformatted Archive (L0Ra) Data Format Control Book (DFCB).

USGS/EROS. LSDS-293. Landsat Data Management Policy.

USGS/EROS. LSDS-524. Landsat Metadata Description Document (LMDD).

USGS/EROS. LSDS-1388. Landsat Cloud Optimized GeoTIFF (COG) Data Format Control Book (DFCB).

USGS/EROS. LSDS-1443. Landsat Enhanced Thematic Mapper Plus (ETM+) Collection 2 (C2) Level 0 Reformatted Product (L0Rp) Data Format Control Book (DFCB).

505-10-36. Earth Science Data and Information System (ESDIS) Project Mission Specific Requirements for the Landsat 7 Mission L1 Processing. November 1998.

GeoTIFF Specification. Revision 1.0. http://geotiff.maptools.org/spec/geotiffhome.html.

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