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Department of the Interior
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LANDSAT MULTISPECTRAL SCANNER (MSS)
LEVEL 1 (L1)
DATA FORMAT CONTROL BOOK (DFCB)

Version 6.0

August 2013

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Approved By:

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Executive Summary

This Data Format Control Book (DFCB) presents detailed data formats of the Multispectral Scanner (MSS) output files that the Level 1 (L1) Product Generation System (LPGS) generates. These L1 processing systems produce L1 output files using Level 0 Reformatted (L0R) images as input. The standard output format used to generate images from the LPGS is the Geographic Tagged Image File Format (GeoTIFF) format.

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

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Section 1 Introduction

1.1 Purpose

This Data Format Control Book (DFCB) provides a high-level description of the Landsat Multispectral Scanner (MSS) Level 1 (L1) distribution product, output product packaging, and viewing tools. This document outlines Landsat 1-5 MSS data products. The different MSS data types include Multispectral Scanner–Processed Format (MSS-P), Multispectral Scanner–X Format (MSS-X), and Multispectral Scanner–A Format (MSS-A).

1.2 Scope

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

The file formats contained in this DFCB are applicable to the LPGS-generated product, operated at the U.S. Geological Survey (USGS) Earth Resources Observation and Science (EROS) Center.

1.3 Intended Users

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

1.4 Definitions

Level 0 Reformatted Archive (L0Ra) product - Raw Computer Compatible (RCC) data that have been reformatted to support data production and includes individual band, browse data, a Mirror Scan Correction Data (MSCD) file, a Payload Correction Data (PCD) file, and Scene Metadata

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

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

- L0Rp digital image (one file per band)
- Internal Calibrator (IC) data - Calibration data file containing all of the calibration data received on a major frame basis subset to the product size ordered
- MSCD - Scan direction and error information subset to the product size ordered
- 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) - A formatted file containing radiometric and geometric correction parameters

- Scan Line Offsets (SLO) - Information on actual starting and ending pixel positions for valid image data on a line-by-line basis
- Geolocation table - File containing scene corner coordinates and product-specific scene line numbers for bands
- HDF directory - File containing all of the pointers, file size information, and data objects required to process the L0Rp product
- Annotation File - Contains the tic marks required for mapping scene-based u,v coordinates to projection space

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

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

Level 1 Systematic Corrected (L1G) digital image - Radiometrically corrected and resampled for geometric correction and registration to a geographic map projection

L1G product - L1 product distributed to the customer that includes, for all bands, a GeoTIFF format L1G image and associated data accommodated by the format

Level 1 Systematic Terrain (Corrected) (L1Gt) product - L1Gt Terrain Correction product that includes radiometric and geometric corrections, and uses a Digital Elevation Model (DEM) to correct parallax error due to local topographic relief. The accuracy of the terrain-corrected product depends on the accuracy of the geometry off the spacecraft when Ground Control Points (GCPs) are not used. L1Gt products are not recommended as output products for MSS data because of the likelihood for inaccurate terrain correction and subsequent precision modeling, and are often more inaccurate than the systematic product.

Level 1 Terrain Corrected (L1T) product - Includes radiometric, geometric, and precision correction, and uses a DEM to correct parallax error due to local topographic relief. The accuracy of the terrain-corrected product depends on the availability of GCPs and the resolution of the best available DEM.

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.

The WRS system design is tied to orbital parameters such as inclination and mean motion; thus, swathing patterns and repeat cycles are different if these orbital parameters are different. Because Landsats 1-3 orbit on an 18-day repeat cycle, and Landsats 4, 5, and 7 orbit on a 16-day repeat cycle, each set completes a different number of orbits before covering the same area on the Earth. This difference in repeat

cycles is the impetus for the difference in the number of paths between the WRS-1 and WRS-2.

WRS-1, used for Landsats 1-3, divides the Earth into 251 paths and 248 rows, for a total of 62,248 scenes. Each WRS-1 scene represents approximately 25 seconds of flight. WRS-2, used for Landsats 4, 5, and 7, grids the Earth into 233 paths by 248 rows. The WRS-2 structure defines 57,784 scene centers, 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 L0 data format contains wideband data processed from the Landsats 1-5 spacecraft. The L0 format is the standard output format of the Landsat Archive Conversion System (LACS) and Multispectral Scanner – X Format Archive Conversion System (MACS). The LACS and MACS output conforms to the L0 format that the USGS uses. This format supports multiple data types for the MSS sensor, including MSS-P, MSS-X, and MSS-A.

The archived MSS data are processed through an "MSS formatter" to make the format similar to that of Landsat 7 Enhanced Thematic Mapper Plus (ETM+) and Landsat 4 / Landsat 5 Thematic Mapper (TM). This makes the data format consistent among the different MSS data types (P, X, and A), compatible with the L1 processing systems, and easier to work with for those already familiar with the ETM+ and TM L0Rp formats. Although archived MSS data have often been geometrically and/or radiometrically corrected to some degree, this reformatted product is referred to as "MSS L0Rp" because of its similarities to other L0Rp data sets (with respect to format and role as input to L1 processing).

The MSS L0Rp format consists of an HDF 4 data set composed of several files (an HDF catalog file, four image band files, and a variable number of metadata files, based on the MSS data type). It also includes a CPF.

Section 2 Overview of the L1 Output Files

The L1G digital image is radiometrically and geometrically corrected, and is available in GeoTIFF format. The L1T product includes radiometric, geometric, and precision correction, and uses a DEM to correct parallax error due to local topographic relief. The processing level to which an image is generated is determined by the best available level for that particular scene, based on available DEM and GCPs for precision modeling. L1Gt products are not recommended as output products for MSS data because without precision GCPs, the geometric accuracy is not precise enough to apply a DEM. L1Gt is currently only used in Antarctica for Landsat 7.

The on-demand L1 products available for download at no charge are generated using a standard set of parameters. These products are output using the best available processing level for that particular scene (L1G or L1T). The processing parameters and output product details used for all standard products are as follows:

- Pixel Size — 60 meter (m)
- Output Format — GeoTIFF
- Resampling Method — Cubic Convolution (CC)
- Map Projection — Universal Transverse Mercator (UTM)
Polar Stereographic (PS) for Antarctica scenes
- Datum — World Geodetic System 1984 (WGS84)
- Image Orientation — Map (North Up (NUP))
- Distribution — File Transfer Protocol (FTP) or Hypertext Transfer Protocol (HTTP) download

Table 2-1 details the MSS L1 product components included with each format. The number of bands and optional data files that the user orders determines the number of components included with a specific product.

Component	L1G	L1T
L1 image file (for each band)	X	X
L1 Metadata file (text [.txt] file)	X	X
GCP file (text [.txt] file)		X
3 Band Verification Browse Image (JPEG [.jpg] file)		X
Geometric Verification Statistics file (text [.txt] file)		X

Table 2-1. GeoTIFF Product Components

2.1 GeoTIFF

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

<LANDSAT_SCENE_ID>_BN.XXX, where LANDSAT_SCENE_ID is LMSPPPRRRYYYYDOYGSIVV, where

L	=	L = Landsat
M	=	Mission: M = Landsat MSS
S	=	Satellite: 1 = Landsat 1 2 = Landsat 2 3 = Landsat 3 4 = Landsat 4 5 = Landsat 5
PPP	=	Three-digit starting path
RRR	=	Three-digit starting row
YYYY	=	Four-digit acquisition year
DOY	=	Three-digit acquisition day of year
GSI	=	Ground Station Identifier
VV	=	Two-digit version
BN	=	Band Number: B1 = Band 1 B2 = Band 2 B3 = Band 3 B4 = Band 4 B5 = Band 5 B6 = Band 6 B7 = Band 7
XXX	=	File type: = TIF file extension for all image data = jpg file extension for the verification browse = txt file extension for GCP, VER, and Metadata (MTL) files

Table 2-2. GeoTIFF Product Naming Convention

2.2 L1 Image File

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 encode into the same file. The GeoTIFF file is grayscale, scan line, uncompressed, and 8-bit unsigned integers.

2.3 L1 Metadata (MTL) Files

The MTL file is created during product generation and contains information specific to the product ordered. Table 2-3 lists the full contents of the MTL file. This file contains all applicable image description information from the L0Rp metadata file. The MTL file complies with LSDS-524 Landsat Metadata Description Document (LMDD) (see References).

Vdata Name: LMSPPPRRRYYYYDDDGSIVV_MTL.txt
Vdata Class: LPGS_Metadata
Interlace Type: FULL_INTERLACE
Bytes Per Logical Record: 65535
Number of Records: One record.

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description/Remarks
GROUP	18	= L1_METADATA_FILE	Beginning of the first-level Object Description Language (ODL) group; it indicates the start of the L1 MTL file level group.
GROUP	18	= METADATA_FILE_INFO	Beginning of the MTL file information group.
ORIGIN	47	= "Image courtesy of the U.S. Geological Survey"	Establishes the origin of the image from the USGS.
REQUEST_ID	19	USGS products use: "NNNYYMMDDSSSS_UUUUU" format where: NNNYYMMDDSSSS = 13-digit Tracking, Routing, 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	Data producer-defined request number that uniquely identifies each product. USGS products use a unique product generation TRAM-generated request ID.
LANDSAT_SCENE_ID	21	= LMSPPPRRRYYYYDDDGSIVV Where: L = Landsat M = MSS S = Satellite PPP = WRS Path RRR = WRS Row YYYY = Year of Acquisition DDD = Day of Acquisition Year GSI = Ground Station Identifier VV = Version	Unique Landsat scene identifier. (Earth-imaging), orbital path/row
FILE_DATE	20	= 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)	L1 system date and time when the metadata file for the L1 product set was created.

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description/Remarks
		MI = Minutes (00-59) SS = Seconds (00-59) Z = Zulu time (same as GMT)	
STATION_ID	3	= “EDC”	Unique three-letter code identifying the originating Ground Station.
PROCESSING_SOFTWARE_VERSION	20	= “SYSTEM_VERSION” Where: SYSTEM = LPGS, IAS VERSION = Version of software	Software name followed by version number(s) and separated by underscores. Example: LPGS_8.2.3
DATA_CATEGORY	11	= “NOMINAL” = “VALIDATION” = “EXCHANGE” = “TEST” = “ENGINEERING”	Current data category assigned to the data. Values: NOMINAL = Nominal data that exists within expected, acceptable limits. VALIDATION = Validation data obtained from an International Ground Station (IGS) in order to validate that the IGS data are of equivalent quality to those that the USGS maintains. EXCHANGE = Exchange data (between an IGS and the USGS) that require a quarantine period and have been successfully validated to be of equivalent quality to the corresponding USGS data. TEST = Test data. ENGINEERING = Engineering data that typically results from an inclination change to the spacecraft or Delta I Maneuver. Refer to LSDS-293 Landsat Data Management Policy.
END_GROUP	18	= METADATA_FILE_INFO	End of the metadata information group.
GROUP	16	= PRODUCT_METADATA	Beginning of the product metadata group.
DATA_TYPE	20	= “L1T” = “L1G” = “L1GT”	Identifier to inform the user of the data type.
DATA_TYPE_L0RP	20	= “MSSA_L0RP” = “MSSX_L0RP” = “MSSP_L0RP” = “MSSR_L0RP”	Data type identifier string used to create the L0Rp product.
ELEVATION_SOURCE	7	= “GLS2000”	Digital elevation data set

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description/Remarks
		= “RAMP”	used to terrain-correct the product. Values: GLS2000 = Global Land Survey 2000. RAMP = Radarsat Antarctic Mapping Project.
OUTPUT_FORMAT	7	= “GEOTIFF”	Output format of the image. Values: GEOTIFF = Geostationary Earth Orbit Tagged Image File Format.
EPHEMERIS_TYPE	10	= “DEFINITIVE” = “PREDICTIVE”	Identifier to inform the user of the orbital ephemeris type used. If the field is not present, the user should assume PREDICTIVE in all cases (L1G product only).
SPACECRAFT_ID	9	= “LANDSAT_1” = “LANDSAT_2” = “LANDSAT_3” = “LANDSAT_4” = “LANDSAT_5”	Name of the satellite platform.
SENSOR_ID	8	= “MSS”	Name of the imaging sensor. MSS = Multispectral Scanner.
WRS_PATH	3	= NNN, where NNN = Path number (001-251)	WRS-defined nominal Landsat satellite track (path). (orbital)
WRS_ROW	3	= NNN, where NNN = Row of the first full or partial scene in the product (001-248)	WRS-defined nominal Landsat satellite row, based on the latitudinal center frame of a Landsat image. (orbital)
DATE_ACQUIRED	10	= YYYY-MM-DD	Date that this scene was imaged.
SCENE_CENTER_TIME	14	= "HH:MI:SS.SSSSSSSZ Where: HH = Hour (00-23) MI = Minutes SS.SSSSSSS = Fractional seconds Z = Constant (indicates ""Zulu"" time (same as GMT)).	Scene center time of the date the image was acquired.
CORNER_UL_LAT_PRODUCT	7	= -90.00000 through +90.00000 degrees. Positive (+) value indicates north latitude; negative (-) value indicates south latitude	Latitude value for the upper-left corner of the product (the L1 systems recalculate for the L1G product).
CORNER_UL_LON_PRODUCT	8	= -180.00000 through +180.00000 degrees. Positive (+) value indicates east longitude; negative (-) value	Longitude value for the upper-left corner of the product (the L1 systems recalculate for the L1G

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description/Remarks
		indicates west longitude	product).
CORNER_UR_LAT_PRODUCT	7	= -90.00000 through +90.00000 degrees.	Latitude value for the upper-right corner of the product (the L1 systems recalculate for the L1G product).
CORNER_UR_LON_PRODUCT	8	= -180.00000 through +180.00000 degrees.	Longitude value for the upper-right corner of the product (the L1 systems recalculate for the L1G product).
CORNER_LL_LAT_PRODUCT	7	= -90.00000 through +90.00000 degrees.	Latitude value for the lower-left corner of the product (the L1 systems recalculate for the L1G product).
CORNER_LL_LON_PRODUCT	8	= -180.00000 through +180.00000 degrees.	Longitude value for the lower-left corner of the product (the L1 systems recalculate for the L1G product).
CORNER_LR_LAT_PRODUCT	7	= -90.00000 through +90.00000 degrees.	Latitude value for the lower-right corner of the product (the L1 systems recalculate for the L1G product).
CORNER_LR_LON_PRODUCT	8	= -180.00000 through +180.00000 degrees.	Longitude value for the lower-right corner of the product (the L1 systems recalculate for the L1G product).
CORNER_UL_PROJECTION_X_ PRODUCT	14	= -132000000.000 through 132000000.000 Units are feet or meters	Projection X coordinate for the upper-left corner of the product (the L1 systems calculated, L1G only).
CORNER_UL_PROJECTION_Y_ PRODUCT	14	= -132000000.000 through 132000000.000 Units are feet or meters	Projection Y coordinate for the upper-left corner of the product (L1 systems calculated, L1G only).
CORNER_UR_PROJECTION_X_ PRODUCT	14	= -132000000.000 through 132000000.000 Units are feet or meters	Projection X coordinate for the upper-right corner of the product (L1 systems calculated, L1G only).
CORNER_UR_PROJECTION_Y_ PRODUCT	14	= -132000000.000 through 132000000.000 Units are feet or meters	Projection Y coordinate for the upper-right corner of the product (L1 systems calculated, L1G only).
CORNER_LL_PROJECTION_X_ PRODUCT	14	= -132000000.000 through 132000000.000 Units are feet or meters	Projection X coordinate for the lower-left corner of the product (L1 systems calculated, L1G only).
CORNER_LL_PROJECTION_Y_ PRODUCT	14	= -132000000.000 through 132000000.000	Projection Y coordinate for the lower-left corner of the

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description/Remarks
		Units are feet or meters	product (L1 systems calculated, L1G only).
CORNER_LR_PROJECTION_X_PRODUCT	14	= -132000000.000 through 132000000.000 Units are feet or meters	Projection X coordinate for the lower-right corner of the product (L1 systems calculated, L1G only).
CORNER_LR_PROJECTION_Y_PRODUCT	14	= -132000000.000 through 132000000.000 Units are feet or meters	Projection Y coordinate for the lower-right corner of the product (L1 systems calculated, L1G only).
REFLECTIVE_LINES	5	= NNNNN	Number of product lines for the reflective bands.
REFLECTIVE_SAMPLES	5	= NNNNN	Number of product samples for the reflective bands.
FILE_NAME_BAND_1	256	"<LANDSAT_SCENE_ID>_B1.TIF"	L1-generated external element file name for Band 1, if part of the product.
FILE_NAME_BAND_2	256	"<LANDSAT_SCENE_ID>_B2.TIF"	L1-generated external element file name for Band 2, if part of the product.
FILE_NAME_BAND_3	256	"<LANDSAT_SCENE_ID>_B3.TIF"	L1-generated external element file name for Band 3, if part of the product.
FILE_NAME_BAND_4	256	"<LANDSAT_SCENE_ID>_B4.TIF"	L1-generated external element file name for Band 4, if part of the product.
FILE_NAME_BAND_5	256	"<LANDSAT_SCENE_ID>_B5.TIF"	L1-generated external element file name for Band 5, if part of the product.
FILE_NAME_BAND_6	256	"<LANDSAT_SCENE_ID>_B6.TIF"	L1-generated external element file name for Band 6, if part of the product.
FILE_NAME_BAND_7	256	"<LANDSAT_SCENE_ID>_B7.TIF"	L1-generated external element file name for band 7, if part of the product.
PRESENT_BAND_1	1	= "Y" (Yes) = "N" (No) = "M" (Missing) = "U" (Unknown)	Presence of Band 1. Values: Y = Band 1 is present. N = Band 1 is not present and is not expected. M = Band 1 is missing (expected but not there). U = Band 1 presence is unknown (expected but insufficient information).
PRESENT_BAND_2	1	= "Y" (Yes) = "N" (No) = "M" (Missing) = "U" (Unknown)	Presence of Band 2. Values: Y = Band 2 is present. N = Band 2 is not present and is not expected. M = Band 2 is missing (expected but not there). U = Band 2

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description/Remarks
			presence is unknown (expected but insufficient information).
PRESENT_BAND_3	1	= “Y” (Yes) = “N” (No) = “M” (Missing) = “U” (Unknown)	Presence of Band 3. Values: Y = Band 3 is present. N = Band 3 is not present and is not expected. M = Band 3 is missing (expected but not there). U = Band 3 presence is unknown (expected but insufficient information).
PRESENT_BAND_4	1	= “Y” (Yes) = “N” (No) = “M” (Missing) = “U” (Unknown)	Presence of Band 4. Values: Y = Band 4 is present. N = Band 4 is not present and is not expected. M = Band 4 is missing (expected but not there). U = Band 4 presence is unknown (expected but insufficient information).
PRESENT_BAND_5	1	= “Y” (Yes) = “N” (No) = “M” (Missing) = “U” (Unknown)	Presence of Band 5. Values: Y = Band 5 is present. N = Band 4 is not present and is not expected. M = Band 5 is missing (expected but not there). U = Band 5 presence is unknown (expected but insufficient information).
PRESENT_BAND_6	1	= “Y” (Yes) = “N” (No) = “M” (Missing) = “U” (Unknown)	Presence of Band 6. Values: Y = Band 6 is present. N = Band 6 is not present and is not expected. M = Band 6 is missing (expected but not there). U = Band 6 presence is unknown (expected but insufficient information).
PRESENT_BAND_7	1	= “Y” (Yes) = “N” (No) = “M” (Missing) = “U” (Unknown)	Presence of Band 7. Values: Y = Band 7 is present. N = Band 4 is not present and is not expected. M = Band 7 is missing (expected but not there). U = Band 7 presence is unknown (expected but insufficient information).

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description/Remarks
GROUND_CONTROL_POINT_FILE_NAME	256	“<LANDSAT_SCENE_ID>_GCP.txt”	L1-generated external element file name for the GCP, if part of the product.
REPORT_VERIFY_FILE_NAME	256	“<LANDSAT_SCENE_ID>_VER.txt	L1-generated external element file name where information from the scoring of geometric verification is located.
BROWSE_VERIFY_FILE_NAME	256	“<LANDSAT_SCENE_ID>_VER.jpg	L1-generated external element file name for the 3 Band Browse file (JPEG file), if part of the product.
METADATA_ FILE_NAME	256	"<LANDSAT_SCENE_ID>_MTL.txt	Name of the metadata file.
CPF_NAME	256	LMXCPFYYYYMMDD_YYYYMMDD.nn where: L = Landsat M = MSS X = Mission 1 = Landsat 1 2 = Landsat 2 3 = Landsat 3 4 = Landsat 4 5 = Landsat 5 YYYYMMDD = effective_date_begin and effective_date_end respectively nn = version (00-99)	Archive-generated external element file name for the Image Assessment System (IAS) CPF.
END_GROUP	16	= PRODUCT_METADATA	End of the product metadata group.
GROUP	17	= IMAGE_ATTRIBUTES	Beginning of the image attributes group.
CLOUD_COVER	5	0.00-100.00, -1	Cloud coverage (percent) assigned to a WRS scene. Values: -1 = Cloud cover not calculated or assessed.
CLOUD_COVER_AUTOMATED_L1	5	0.00-100.00, -1	Automated cloud cover (percent) on a WRS L1 scene. Values: -1 = Cloud cover not calculated or assessed.
IMAGE_QUALITY	1	0-9, -1	Composite image quality for the bands. Values: 9 = Best. 0 = Worst. -1 = Image quality not calculated or assessed.
SUN_AZIMUTH	11	= -180.00000000 through 180.00000000 degrees. A positive value indicates angles to the east or clockwise from the north. A negative value (-) indicates angles to the west or counterclockwise from	Sun azimuth angle in degrees for the image center location at the image center acquisition time.

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description/Remarks
		the north. Leading zeros are not required.	
SUN_ELEVATION	10	= -90.00000000 through 90.00000000 degrees. A positive value indicates a daytime scene. A negative value (-) indicates a nighttime scene. Leading zeros are not required.	Sun elevation angle in degrees for the image center location at the image center acquisition time.
GROUND_CONTROL_POINTS_MODEL	3	= 1 - 999	Number of GCPs used in the precision correction process.
GEOMETRIC_RMSE_MODEL	7	= 0.000 – 9999.999	Combined Root Mean Square Error (RMSE) of the geometric residuals (meters) in both across-track and along-track directions measured on the GCPs used in geometric precision correction.
GEOMETRIC_RMSE_MODEL_Y	7	= 0.000 – 9999.999	RMSE of the geometric residuals (meters) measured on the GCPs used in geometric precision correction.
GEOMETRIC_RMSE_MODEL_X	7	= 0.000 – 9999.999	RMSE of the geometric residuals (meters) measured on the GCPs used in geometric precision correction.
GROUND_CONTROL_POINTS_VERIFY	4	= 1 - 9999	Number of GCPs used in the verification of the terrain corrected product.
GEOMETRIC_RMSE_VERIFY	7	= 0.000 – 9999.999	RMSE of the geometric residuals (pixels) in both line and sample directions measured on the terrain-corrected product independently using GLS2000.
GEOMETRIC_RMSE_VERIFY_QUAD_UL	7	= 0.000 – 9999.999	RMSE of the geometric residuals (pixels) for the upper-left quadrant in both line and sample directions measured on the terrain-corrected product independently using GLS2000.
GEOMETRIC_RMSE_VERIFY_QUAD_UR	7	= 0.000 – 9999.999	RMSE of the geometric residuals (pixels) for the upper-right quadrant in both line and sample directions measured on the

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description/Remarks
			terrain-corrected product independently using GLS2000.
GEOMETRIC_RMSE_VERIFY_QUAD_LL	7	= 0.000 – 9999.999	RMSE of the geometric residuals (pixels) for the lower-left quadrant in both line and sample directions measured on the terrain-corrected product independently using GLS2000.
GEOMETRIC_RMSE_VERIFY_QUAD_LR	7	= 0.000 – 9999.999	RMSE of the geometric residuals (pixels) for the lower-right quadrant in both line and sample directions measured on the terrain-corrected product independently using GLS2000.
END_GROUP	17	= IMAGE_ATTRIBUTES	End of the image attributes group.
GROUP	16	= MIN_MAX_RADIANCE	Beginning of the minimum / maximum radiance group (L1G product only).
RADIANCE_MAXIMUM_BAND_1	6	= 0.000 – 999.999	Maximum achievable spectral radiance value for Band 1, if part of the product (w/(m^2 sr micron)). In addition, the spectral radiance corresponding to QUANTIZE_CAL_MAX_BAND_1.
RADIANCE_MINIMUM_BAND_1	6	= -999.999 through 999.999	Minimum achievable spectral radiance value for Band 1, if part of the product (w/(m^2 sr micron)). In addition, the spectral radiance corresponding to QUANTIZE_CAL_MIN_BAND_1.
RADIANCE_MAXIMUM_BAND_2	6	= 0.000 – 999.999	Maximum achievable spectral radiance value for Band 2, if part of the product (w/(m^2 sr micron)). In addition, the spectral radiance corresponding to QUANTIZE_CAL_MAX_BAND_2.
RADIANCE_MINIMUM_BAND_2	6	= -999.999 through 999.999	Minimum achievable spectral radiance value for

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description/Remarks
			Band 2, if part of the product (w/(m^2 sr micron)). In addition, the spectral radiance corresponding to QUANTIZE_CAL_MIN_BAND_2.
RADIANCE_MAXIMUM_BAND_3	6	= 0.000 – 999.999	Maximum achievable spectral radiance value for Band 3, if part of the product (w/(m^2 sr micron)). In addition, the spectral radiance corresponding to QUANTIZE_CAL_MAX_BAND_3.
RADIANCE_MINIMUM_BAND_3	6	= -999.999 through 999.999	Minimum achievable spectral radiance value for Band 3, if part of the product (w/(m^2 sr micron)). In addition, the spectral radiance corresponding to QUANTIZE_CAL_MIN_BAND_3.
RADIANCE_MAXIMUM_BAND_4	6	= 0.000 – 999.999	Maximum achievable spectral radiance value for Band 4, if part of the product (w/(m^2 sr micron)). In addition, the spectral radiance corresponding to QUANTIZE_CAL_MAX_BAND_4.
RADIANCE_MINIMUM_BAND_4	6	= -999.999 through 999.999	Minimum achievable spectral radiance value for Band 4, if part of the product (w/(m^2 sr micron)). In addition, the spectral radiance corresponding to QUANTIZE_CAL_MIN_BAND_4.
RADIANCE_MAXIMUM_BAND_5	6	= 0.000 – 999.999	Maximum achievable spectral radiance value for Band 5, if part of the product (w/(m^2 sr micron)). In addition, the spectral radiance corresponding to QUANTIZE_CAL_MAX_BAND_5.
RADIANCE_MINIMUM_BAND_5	6	= -999.999 through 999.999	Minimum achievable

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description/Remarks
			spectral radiance value for Band 5, if part of the product (w/(m^2 sr micron)). In addition, the spectral radiance corresponding to QUANTIZE_CAL_MIN_BAND_5.
RADIANCE_MAXIMUM_BAND_6	6	= 0.000 – 999.999	Maximum achievable spectral radiance value for Band 6, if part of the product (w/(m^2 sr micron)). In addition, the spectral radiance corresponding to QUANTIZE_CAL_MAX_BAND_6.
RADIANCE_MINIMUM_BAND_6	6	= -999.999 through 999.999	Minimum achievable spectral radiance value for Band 6, if part of the product (w/(m^2 sr micron)). In addition, the spectral radiance corresponding to QUANTIZE_CAL_MIN_BAND_6.
RADIANCE_MAXIMUM_BAND_7	6	= 0.000 – 999.999	Maximum achievable spectral radiance value for Band 7, if part of the product (w/(m^2 sr micron)). In addition, the spectral radiance corresponding to QUANTIZE_CAL_MAX_BAND_7.
RADIANCE_MINIMUM_BAND_7	6	= -999.999 through 999.999	Minimum achievable spectral radiance value for Band 7, if part of the product (w/(m^2 sr micron)). In addition, the spectral radiance corresponding to QUANTIZE_CAL_MIN_BAND_7.
END_GROUP	16	= MIN_MAX_RADIANCE	End of the minimum / maximum radiance group.
GROUP	19	= MIN_MAX_PIXEL_VALUE	Beginning of the minimum / maximum pixel value group (L1G product only).
QUANTIZE_CAL_MAX_BAND_1	3	= 0 - 255	Maximum possible pixel value for Band 1, if part of the product (DN).
QUANTIZE_CAL_MIN_BAND_1	1	= 0 - 1	Minimum possible pixel

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description/Remarks
			value for Band 1, if part of the product (DN).
QUANTIZE_CAL_MAX_BAND_2	3	= 0 - 255	Maximum possible pixel value for Band 2, if part of the product (DN).
QUANTIZE_CAL_MIN_BAND_2	1	= 0 - 1	Minimum possible pixel value for Band 2, if part of the product (DN).
QUANTIZE_CAL_MAX_BAND_3	3	= 0 - 255	Maximum possible pixel value for Band 3, if part of the product (DN).
QUANTIZE_CAL_MIN_BAND_3	1	= 0 - 1	Minimum possible pixel value for Band 3, if part of the product (DN).
QUANTIZE_CAL_MAX_BAND_4	3	= 0 - 255	Maximum possible pixel value for Band 4, if part of the product (DN).
QUANTIZE_CAL_MIN_BAND_4	1	= 0 - 1	Minimum possible pixel value for Band 4, if part of the product (DN).
QUANTIZE_CAL_MAX_BAND_5	3	= 0 - 255	Maximum possible pixel value for Band 5, if part of the product (DN).
QUANTIZE_CAL_MIN_BAND_5	1	= 0 - 1	Minimum possible pixel value for Band 5, if part of the product (DN).
QUANTIZE_CAL_MAX_BAND_6	3	= 0 - 255	Maximum possible pixel value for Band 6, if part of the product (DN).
QUANTIZE_CAL_MIN_BAND_6	1	= 0 - 1	Minimum possible pixel value for Band 6, if part of the product (DN).
QUANTIZE_CAL_MAX_BAND_7	3	= 0 - 255	Maximum possible pixel value for Band 7, if part of the product (DN).
QUANTIZE_CAL_MIN_BAND_7	1	= 0 - 1	Minimum possible pixel value for Band 7, if part of the product (DN).
END_GROUP	19	= MIN_MAX_PIXEL_VALUE	End of the minimum / maximum pixel value group.
GROUP	18	= PRODUCT_PARAMETERS	Beginning of the product parameters group (both 1R and L1G products).
CORRECTION_GAIN_BAND_1	20	= “CPF” (for CPF gains) = “INTERNAL_CALIBRATION” (for IC gains)	Correction method used by L1 in creating the image for Band 1, if part of the product.
CORRECTION_GAIN_BAND_2	20	= “CPF” (for CPF gains) = “INTERNAL_CALIBRATION” (for IC gains)	Correction method used by L1 in creating the image for Band 2, if part of the product.
CORRECTION_GAIN_BAND_3	20	= “CPF” (for CPF gains)	Correction method used by

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description/Remarks
		= “INTERNAL_CALIBRATION” (for IC gains)	L1 in creating the image for Band 3, if part of the product.
CORRECTION_GAIN_BAND_4	20	= “CPF” (for CPF gains) = “INTERNAL_CALIBRATION” (for IC gains)	Correction method used by L1 in creating the image for Band 4, if part of the product.
CORRECTION_GAIN_BAND_5	20	= “CPF” (for CPF gains) = “INTERNAL_CALIBRATION” (for IC gains)	Correction method used by L1 in creating the image for Band 5, if part of the product.
CORRECTION_GAIN_BAND_6	20	= “CPF” (for CPF gains) = “INTERNAL_CALIBRATION” (for IC gains)	Correction method used by L1 in creating the image for Band 6, if part of the product.
CORRECTION_GAIN_BAND_7	20	= “CPF” (for CPF gains) = “INTERNAL_CALIBRATION” (for IC gains)	Correction method used by L1 in creating the image for Band 7, if part of the product.
GAIN_BAND_1	1	= “H” (Band was acquired in high gain mode), = “L” (Band was acquired in low gain mode), = “U” (Unknown)	Band gain state of Band 1 detected at the start of a WRS scene.
GAIN_BAND_2	1	= “H” (Band was acquired in high gain mode), = “L” (Band was acquired in low gain mode), = “U” (Unknown)	Band gain state of Band 2 detected at the start of a WRS scene.
GAIN_BAND_3	1	= “H” (Band was acquired in high gain mode), = “L” (Band was acquired in low gain mode), = “U” (Unknown)	Band gain state of Band 3 detected at the start of a WRS scene.
GAIN_BAND_4	1	= “H” (Band was acquired in high gain mode), = “L” (Band was acquired in low gain mode), = “U” (Unknown)	Band gain state of Band 4 detected at the start of a WRS scene.
GAIN_BAND_5	1	= “H” (Band was acquired in high gain mode), = “L” (Band was acquired in low gain mode), = “U” (Unknown)	Band gain state of Band 5 detected at the start of a WRS scene.
GAIN_BAND_6	1	= “H” (Band was acquired in high gain mode), = “L” (Band was acquired in low gain mode), = “U” (Unknown)	Band gain state of Band 6 detected at the start of a WRS scene.
GAIN_BAND_7	1	= “H” (Band was acquired in high gain mode), = “L” (Band was acquired in low gain	Band gain state of Band 7 detected at the start of a WRS scene.

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description/Remarks
		mode), = “U” (Unknown)	
END_GROUP	18	= PRODUCT_PARAMETERS	End of the product parameters group.
GROUP	21	= RADIOMETRIC_RESCALING	Beginning of the radiometric rescaling parameters group.
RADIANCE_MULT_BAND_1	23	-99999999999999999.999 through +99999999999999999.999	Multiplicative rescaling factor used to convert calibrated digital numbers to reflectance for Band 1 (DN-1).
RADIANCE_MULT_BAND_2	23	-99999999999999999.999 through +99999999999999999.999	Multiplicative rescaling factor used to convert calibrated digital numbers to reflectance for Band 2 (DN-1).
RADIANCE_MULT_BAND_3	23	-99999999999999999.999 through +99999999999999999.999	Multiplicative rescaling factor used to convert calibrated digital numbers to reflectance for Band 3 (DN-1).
RADIANCE_MULT_BAND_4	23	-99999999999999999.999 through +99999999999999999.999	Multiplicative rescaling factor used to convert calibrated digital numbers to reflectance for Band 4 (DN-1).
RADIANCE_MULT_BAND_5	23	-99999999999999999.999 through +99999999999999999.999	Multiplicative rescaling factor used to convert calibrated digital numbers to reflectance for Band 5 (DN-1).
RADIANCE_MULT_BAND_6	23	-99999999999999999.999 through +99999999999999999.999	Multiplicative rescaling factor used to convert calibrated digital numbers to reflectance for Band 6 (DN-1).
RADIANCE_MULT_BAND_7	23	-99999999999999999.999 through +99999999999999999.999	Multiplicative rescaling factor used to convert calibrated digital numbers to reflectance for Band 7 (DN-1).
RADIANCE_ADD_BAND_1	9	-9999.99999 through +9999.99999	Additive rescaling factor used to convert calibrated digital numbers to radiance units (W/(m^2 sr um)) for Band 1.
RADIANCE_ADD_BAND_2	9	-9999.99999 through +9999.99999	Additive rescaling factor used to convert calibrated digital numbers to radiance units (W/(m^2 sr um)) for Band 2.
RADIANCE_ADD_BAND_3	9	-9999.99999 through +9999.99999	Additive rescaling factor

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description/Remarks
			used to convert calibrated digital numbers to radiance units (W/(m^2 sr um)) for Band 3.
RADIANCE_ADD_BAND_4	9	-9999.99999 through +9999.99999	Additive rescaling factor used to convert calibrated digital numbers to radiance units (W/(m^2 sr um)) for Band 4.
RADIANCE_ADD_BAND_5	9	-9999.99999 through +9999.99999	Additive rescaling factor used to convert calibrated digital numbers to radiance units (W/(m^2 sr um)) for Band 5.
RADIANCE_ADD_BAND_6	9	-9999.99999 through +9999.99999	Additive rescaling factor used to convert calibrated digital numbers to radiance units (W/(m^2 sr um)) for Band 6.
RADIANCE_ADD_BAND_7	9	-9999.99999 through +9999.99999	Additive rescaling factor used to convert calibrated digital numbers to radiance units (W/(m^2 sr um)) for Band 7.
END_GROUP	21	= RADIOMETRIC_RESCALING	End of the radiometric rescaling parameters group.
GROUP	21	= PROJECTION_PARAMETERS	Beginning of the projection parameters group (L1G product only).
MAP_PROJECTION	3	= “PS” (Polar Stereographic) = ”UTM” (Universal Transverse Mercator)	L1 map projection applied to this data. Used for processed archive data.
DATUM	5	= “WGS84”	Datum used in creating the image.
ELLIPSOID	5	= “WGS84”	Ellipsoid used in creating the image.
UTM_ZONE	2	= 1 to 60 or -1 to -60	Value used to indicate the zone number.
VERTICAL_LON_FROM_POLE	8	= -180.00000 through +180.00000	Vertical longitude (decimal degrees) from the pole.
TRUE_SCALE_LAT	7	= -90.00000 through +90.00000	Latitude of true scale in a map projection.
FALSE_EASTING	9	= -200000000 through +200000000	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 Planar Coordinate Unit.
FALSE_NORTHING	9	= -200000000 through +200000000	Value added to all "y"

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description/Remarks
			values in the rectangular coordinates for a map projection. Frequently assigned to eliminate negative numbers. Expressed in the unit of measure identified in Planar Coordinate Unit.
GRID_CELL_SIZE_REFLECTIVE	5	= 0.00 – 120.00	Grid cell size used in creating the image for the reflective band.
ORIENTATION	10	= “NORTH_UP”	Orientation used in creating the image.
RESAMPLING_OPTION	28	= “CUBIC_CONVOLUTION”	Resampling option used in creating the image.
MAP_PROJECTION_L0RA	3	= “PS” (Polar Stereographic) = ”UTM” (Universal Transverse Mercator) = “HOM” (Hotine Oblique Mercator) = ”SOM” (Space Oblique Mercator) = ”NA” (Not applicable)	L0Ra map projection selectively applied to High Density Tapes (HDTs) based on geographic location. Used for processed archive data.
END_GROUP	21	= PROJECTION_PARAMETERS	End of projection parameters group.
END_GROUP	16	L1_METADATA_FILE	End of the L1 MTL file parameters.
END			Required standalone parameter signifying the file end.

Table 2-3. MSS L1 Metadata Contents

2.4 GCP File

The GCP file included with an L1T 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 2-4 Example GCP Output File

.

```
Example GCP Output File
================================================================================
Wed. Jan. 20, 2010              LANDSAT 3                  Time: 15:31
                          Image Assessment System
                            GCP Residual Report
--------------------------------------------------------------------------------
WOID: L102784             Path/Row: 003 / 054

L0R Reference Image: L31AAA1179056020201_HDF.100202126
Acquisition Date: Feb 24, 1979

Band Number:  7

GeoCover date for each WRS-2 path/row used:
Path  Row   Date
003   054   2001-03-07
```

```
003   055   2001-03-07
004   053   2001-03-14
004   054   2001-03-14


Point_ID      Latitude  Longitude    Height       Across    Along    Residual  Residual
                                                   Scan      Scan      In y      in x
                                                 Residual  Residual    dir       dir
                 (deg)     (deg)     (meters)    (meters)  (meters)  (meters)  (meters)

0030540010    9.129373  -66.121990   144.657       0.000     0.000    19.057   -39.892
0030540018    9.091815  -66.383349   136.842       0.000     0.000   163.511   -49.191
0030540027    8.802283  -65.888716   135.720       0.000     0.000    20.713   110.596
0030540037    9.013381  -65.993965   126.111       0.000     0.000   -55.552    48.047
0030540038    9.135688  -65.950259   170.401       0.000     0.000    -0.777    34.012
0030540044    9.197323  -66.160217   116.346       0.000     0.000    81.440   -13.813
0030540048    9.053876  -65.878156   119.748       0.000     0.000   -71.034    82.169
0030540049    9.170300  -65.892726   143.408       0.000     0.000   -21.226    52.298
0030540053    9.111896  -66.009506   135.544       0.000     0.000   -21.883    46.452
0030540060    9.249209  -66.051034   141.822       0.000     0.000    84.762   -27.073
0030540068    8.873761  -65.897993   155.437       0.000     0.000   -54.253    88.424
0030540070    9.173863  -66.052569   162.474       0.000     0.000     1.582     2.554
0030540076    8.965733  -65.988122   139.572       0.000     0.000   -47.569    55.096
0030540079    8.823417  -65.889425   147.749       0.000     0.000     7.657    99.631
0030540087    8.932454  -66.145365   121.355       0.000     0.000   -13.303   -17.969
0030540090    8.751917  -65.882877   143.082       0.000     0.000    42.900    72.001
0030540092    9.168104  -65.685411    84.687       0.000     0.000   -12.884   102.017
0030540096    9.034415  -65.871458   136.406       0.000     0.000   -71.557    73.916
0030540100    9.183675  -66.109375   133.445       0.000     0.000    32.663   -49.319
0030540103    9.000062  -65.897357   126.825       0.000     0.000   -54.396   106.185
```

Table 2-4 Example GCP Output File

2.5 Verify File

The Geometric Verification Statistics file included with an L1T product is written in ASCII format and contains a header followed by records, one on each line. Each record has seven column headings and looks similar to Table 2-5. Each record corresponds to a single GCP marked with a colored dot in the 3 Band Verification Browse Image. The contents of the verify file look similar to Table 2-5.

```
Example Verify Output File
================================================================================
Thu. Nov. 1 2012                 LANDSAT                       Time: 16:58
                            Image Assessment System
                            GEOMETRIC VERIFY Report
================================================================================
Order ID: 0101210315929_00002                          Path / Row - 15 / 41
Reference Image: L51AAA1188075150100_HDF.L1G

Color mapping per rank
----------------------
Rank  1 is Green: total residual <= 0.5
Rank  2 is Cyan: 0.5 < total residual <=  1
Rank  3 is Blue:  1 < total residual <=  2
Rank  4 is Yellow:  2 < total residual <=  3
Rank  5 is Red:  3 < total residual

Percentage of residuals by rank
-------------------------------
Rank   1 -- 51.6%
Rank   2 -- 48.4%
Rank   3 --  0.0%
Rank   4 --  0.0%
Rank   5 --  0.0%
```

```
       GCP    Latitude    Longitude  Sample   Line     Total    Rank
        ID                           Residual Residual Residual
              (Degree)    (Degree)   (Pixel)  (Pixel)  (Pixel)
-------------------------------------------------------------------
0150410091   28.32760    -80.69813     0.47      0.47     0.66     2
0150410092   28.32753    -80.66692     0.63      0.33     0.71     2
0150410093   28.32745    -80.63570     0.41      0.01     0.41     1
0150410167   28.30315    -80.66699     0.62      0.29     0.68     2
0150410168   28.30307    -80.63578     0.19      0.08     0.21     1
0150410169   28.30299    -80.60458     0.15     -0.36     0.39     1
0150410242   28.27878    -80.66707     0.27      0.29     0.40     1
0150410244   28.27861    -80.60467     0.77     -0.43     0.88     2
0150410319   28.25424    -80.60476     0.16     -0.14     0.21     1
0150410392   28.23004    -80.66722     0.27      0.29     0.40     1
0150410394   28.22987    -80.60484     0.31     -0.11     0.32     1
0150410467   28.20566    -80.66730     0.24      0.00     0.24     1
0150410468   28.20558    -80.63612     0.16      0.02     0.16     1
0150410469   28.20550    -80.60493     0.23     -0.11     0.26     1
0150410617   28.15692    -80.66745     0.20      0.18     0.27     1
0150410619   28.15675    -80.60511     0.34     -0.13     0.37     1
0150410693   28.13247    -80.63636    -0.06      0.12     0.13     1
0150410694   28.13238    -80.60520     0.01      0.18     0.18     1
0150410766   28.10825    -80.69875     0.06      0.12     0.14     1
0150410843   28.08372    -80.63653    -0.36      0.01     0.36     1
===================================================================================
Thu. Nov. 1 2012                LANDSAT 7                          Time: 16:58
                          Image Assessment System
                          GEOMETRIC VERIFY Report
===================================================================================
Order ID: 0101210315929_00002                          Path / Row - 15 / 41
Reference Image: L51AAA118075150100_HDF.L1G

Color mapping per rank
----------------------
Rank  1 is Green: total residual <= 0.5
Rank  2 is Cyan: 0.5 < total residual <=  1
Rank  3 is Blue:  1 < total residual <=  2
Rank  4 is Yellow:  2 < total residual <=  3
Rank  5 is Red:  3 < total residual

Percentage of residuals by rank
-------------------------------
Rank   1 -- 51.6%
Rank   2 -- 48.4%
Rank   3 --  0.0%
Rank   4 --  0.0%
Rank   5 --  0.0%

       GCP    Latitude    Longitude  Sample   Line     Total    Rank
        ID                           Residual Residual Residual
              (Degree)    (Degree)   (Pixel)  (Pixel)  (Pixel)
-------------------------------------------------------------------
0150410091   28.32760    -80.69813     0.47      0.47     0.66     2
0150410092   28.32753    -80.66692     0.63      0.33     0.71     2
0150410093   28.32745    -80.63570     0.41      0.01     0.41     1
0150410167   28.30315    -80.66699     0.62      0.29     0.68     2
0150410168   28.30307    -80.63578     0.19      0.08     0.21     1
0150410169   28.30299    -80.60458     0.15     -0.36     0.39     1
0150410242   28.27878    -80.66707     0.27      0.29     0.40     1
0150410244   28.27861    -80.60467     0.77     -0.43     0.88     2
0150410319   28.25424    -80.60476     0.16     -0.14     0.21     1
0150410392   28.23004    -80.66722     0.27      0.29     0.40     1
0150410394   28.22987    -80.60484     0.31     -0.11     0.32     1
0150410467   28.20566    -80.66730     0.24      0.00     0.24     1
0150410468   28.20558    -80.63612     0.16      0.02     0.16     1
0150410469   28.20550    -80.60493     0.23     -0.11     0.26     1
0150410617   28.15692    -80.66745     0.20      0.18     0.27     1
0150410619   28.15675    -80.60511     0.34     -0.13     0.37     1
0150410693   28.13247    -80.63636    -0.06      0.12     0.13     1
0150410694   28.13238    -80.60520     0.01      0.18     0.18     1
0150410766   28.10825    -80.69875     0.06      0.12     0.14     1
```

0150410843	28.08372	-80.63653	-0.36	0.01	0.36	1

Table 2-5. Example Verify File

Section 3 L1 Output File Format

3.1 GeoTIFF File Formats

3.1.1 L1 Image File

The description of an image in GeoTIFF requires tags and keys as described in the GeoTIFF Specification document (see References). The L1 image files include these tags and keys, which TIFF readers automatically detect and read. The following sections describe the tags and keys.

Each Earth image band in the requested product is contained in a separate file, as is the optionally available DEM data file. The data are laid out in a scan line sequential format in descending detector order (e.g., detector 16 followed by detector 15 and so forth for the 30 meter bands). The L1G image is radiometrically corrected and resampled for geometric correction and registration to geographic map projections. The L1T image is radiometrically, geometrically, and precision corrected, and uses a DEM to correct parallax error due to local topographic relief.

3.1.1.1 GeoTIFF Tags

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

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

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

The ModelTiepointTag stores the raster-to-model tiepoint pairs in 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 often is an exact, affine transformation, the relationship can be defined

using one set of tiepoints and the ModelPixelScaleTag, which gives the vertical and horizontal raster grid cell size.

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

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

ModelPixelScaleTag = (ScaleX, ScaleY, ScaleZ)

where ScaleX and ScaleY give the horizontal and vertical spacing of raster pixels, and ScaleZ maps the pixel value of a DEM into the correct Z-scale. ScaleZ is not used for L1G 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
UTM		
GTModelTypeGeoKey	1	ModelTypeProjected (Projection Coordinate System)
GTRasterTypeGeoKey	1	RasterPixelIsArea
	2	RasterPixelIsPoint
GTCitationGeoKey	(ASCII, 17)	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
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 MTL File

Please see section 2.3 for L1 MTL file details.

3.1.3 GCP File

Please see section 2.4 for GCP file details.

Section 4 Product Packaging

L1 products are available for distribution via FTP or HTTP download. The following sections provide information on each distribution method for the available L1 product formats.

4.1 Electronic Transfer

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

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

Section 5 Software Tools

5.1 ODL Parser

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

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

Appendix A Projection Parameters

This appendix contains the map projection parameters used in the L1 output products and the USGS projection parameters (Table A-2).

Project Name	Mnemonic
Polar Stereographic	PS
Universal Transverse Mercator	UTM

Table A-1. L1 Output Product Projection Parameters

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-2. 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-3. 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 the ellipsoid. If zero, Clarke 1866 in meters is assumed.
	SMinor	=	Eccentricity squared of the ellipsoid if less than zero. If zero, a spherical form is assumed. If greater than zero, the semi-major axis of the ellipsoid.
	Sphere	=	Radius of the reference sphere. If zero, 6370997 meters 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 below the pole of the map
	TrueScale	=	Latitude of the 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 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, and 7)
	Shapem	=	Oval shape parameter m
	Shapen	=	Oval shape parameter n
	Angle	=	Oval rotation angle

Table A-4. USGS Projection Parameters Key

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

References

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

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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://www.remotesensing.org/geotiff/spec/geotiffhome.html).

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