Department of the Interior
U.S. Geological Survey

ADVANCED LAND IMAGER (ALI) LEVEL 1G (L1G) PRODUCT OUTPUT FILES DATA FORMAT CONTROL BOOK (DFCB)

Earth Observing-1 (EO-1)

Version 4.0

October 2005

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Earth Observing-1 (EO-1)

October 2005

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Executive Summary

This Advanced Land Imager (ALI) Level 1G (L1G) Data Format Control Book (DFCB) presents detailed data formats of the output files generated by the Earth Observing-1 (EO-1) Product Generation (EPG) System. The level 1 processing system produces level 1 output files from Level 0R (L0R) images based on user requests. Images in the following formats are possible from the level 1 processing system: Hierarchical Data Format (HDF) or Geographic Tagged Image File Format (GeoTIFF).

This DFCB is maintained and controlled by the EO-1 Configuration Control Board (CCB) and may be updated or revised only on approval by the EO-1 CCB. Comments and questions regarding this DFCB should be directed to:

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Section 1 Introduction

1.1 Purpose

This Data Format Control Book (DFCB) provides the user with a high-level description of the Advanced Land Imager (ALI) Level 1G (L1G) distribution product, product packaging, and viewing tools.

1.2 Scope

This DFCB describes the formats and data contents of the L1G output files. The formats discussed are Hierarchical Data Format (HDF) and Geographic Tagged Image File Format (GeoTIFF).

The HDF L1G product formats are primarily derived from the formats of the Landsat 7 L1G products to cause less impact on the user community and to provide general consistency in output. In addition, the output files defined in this DFCB are based on the already established GeoTIFF standards.

The file formats contained in this DFCB are applicable to the product generated by L1G producing systems operated at the United States Geological Survey (USGS) National Center for Earth Resources Observation and Science (EROS).

1.3 Intended Users

This document is intended as a guide to recipients of L1G products. This document contains detailed information on the L1G output data file formats, which will allow users to proceed with independent development of L1G processing capability. It also provides detailed information on the packaging of the L1G product.

1.4 Definitions

Level 0R (L0R) — Data that has no corrections applied.

Level 1R (L1R) — Radiometrically corrected only. No geometric corrections are applied.

Level 1Gs (L1Gs) — Radiometrically corrected and resampled for geometric correction and registered to a geographic map projection.

Level 1Gst (L1Gst) — Radiometrically corrected and resampled for geometric correction and registration to a geographic map projection. The image data is also ortho-corrected using digital elevation models (DEM) to correct parallax error due to local topographic relief. The source of DEM used will vary according to local availability of elevation information.

1.5 L0 Pre-Archive Processing

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

At EROS, the Data Capture and Processing Facility (DCPF) uses a 5.4-meter antenna to acquire ALI and Hyperion data directly from the EO-1 spacecraft by way of one 105-megabits-per-second (Mbps) X-band return link. At the 5.4-meter ground station, the X-band data link is separated into two 52.5-Mbps channels (I and Q) and captured by the Data Processing System Real Time (DPSRT) in real-time.

The housekeeping data is downlinked using the S-band to the various receiving stations. The data is transferred, via the network, to a system at Goddard Space Flight Center (GSFC), which in turn transfers it to the Data Processing System (DPS) in the order it was received by the ground stations. The DPS re-orders the data in spacecraft sequence and eliminates any duplicates. The housekeeping data, which includes ephemeris data, is then stored in the housekeeping HDF files. The image (X-band) data is de-interleaved and reformatted as level-0 data.

During ingest to the archive, metadata and browse are generated for the image. The image data, calibration data, and metadata are sent to the archive. The browse files are sent to the search and order systems separately for use as an online aid to ordering.

Section 2 Overview of Level 1 Output Files

The L1G digital image is radiometrically and geometrically corrected and is available in two format options: GeoTIFF and HDF.

Table 2-1 and Table 2-2 detail the level 1 product components for each format.

Component
Level 1 image file (one for each band)
Level 1 metadata file
Federal Geographic Data Committee (FGDC) metadata file
Readme file

Table 2-1. GeoTIFF Product Components

Component
Level 1 image file (one for each band)
Level 1 metadata file
HDF directory file
FGDC metadata file
Readme file

Table 2-2. HDF Product Components

2.1 GeoTIFF

The file naming convention for the GeoTIFF product is EO1spppprrrYYYYDDDXXXML_AAA_CCC.TIF

EO1	=	EO-1 mission
s	=	Sensor, A = ALI, H = Hyperion
ppp	=	Target Worldwide Reference System (WRS) path of the product
rrr	=	Target WRS row of the product
YYYY	=	Acquisition year of the image
DDD	=	Acquisition Julian day of year
XXX	=	Hyperion, ALI, AC, (1 = sensor on, 0 = sensor off)
M	=	Pointing Mode: P = Pointed within path/row, K = Pointed outside path/row, N = Nadir
L	=	Scene Length F = Full scene P = Partial scene Q = Second partial scene S = Swath 0 - 9 = Special modes 0 - 9 Remainder of alphabet are EROS collects
AAA	=	file type: B01 = band 1 (Pan) B02 = band 2 (MS –1') B03 = band 3 (MS – 1) B04 = band 4 (MS – 2) B05 = band 5 (MS – 3) B06 = band 6 (MS – 4) B07 = band 7 (MS – 4') B08 = band 8 (MS – 5') B09 = band 9 (MS – 5) B10 = band 10 (MS – 7) MTL = Level 1 metadata
CCC	=	L1G = systematic corrected L1T = systematic terrain corrected
.TIF	=	GeoTIFF file extension

Table 2-3. GeoTIFF Product Naming Convention Level 1 Metadata File

2.1.1 Level 1 Image File

GeoTIFF defines a set of public domain TIFF tags that describe all cartographic and geodetic information associated with geographic TIFF 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. The GeoTIFF file is grayscale, uncompressed, and 16-bit signed integers.

2.1.2 Ancillary Data Files

For a complete listing of the remaining files included with the GeoTIFF product see Table 2-1. These files are described in detail in Section 3.3.

2.2 HDF

The L1G HDF products are packaged and distributed as a collection of external elements with an HDF directory. External elements are distinguished by the fact that they exist as separate files and contain only data. Information about their HDF structure and interrelationships can be found in the HDF directory.

The file naming convention for the HDF product files is EO1spprrrYYYYDDDXXXML_AAA.CCC

EO1	=	Earth Observing 1 mission
s	=	Sensor, A = ALI, H = Hyperion
ppp	=	Target WRS path of the product
rrr	=	Target WRS row of the product
YYYY	=	Acquisition year of the image
DDD	=	Acquisition Julian day of year
XXX	=	Hyperion, ALI, AC, (1 = sensor on, 0 = sensor off)
M	=	Pointing Mode, P = Pointed within path/row, K = Pointed outside path/row, N = Nadir
L	=	Scene Length, F = Full scene P = Partial scene Q = Second partial scene S = Swath 0 - 9 = Special modes 0 - 9 Remainder of alphabet are EROS collects
AAA	=	file type: B01 = band 1 (Pan) B02 = band 2 (MS –1') B03 = band 3 (MS – 1) B04 = band 4 (MS – 2) B05 = band 5 (MS – 3) B06 = band 6 (MS – 4) B07 = band 7 (MS – 4') B08 = band 8 (MS – 5') B09 = band 9 (MS – 5) B10 = band 10 (MS – 7) HDF = HDF directory MTL = Level 1 metadata
.CCC	=	product type: L1G = systematic corrected L1T = systematic terrain corrected

Table 2-4. HDF Naming Convention

2.2.1 Level 1 Image File

The L1G digital values represent absolute radiance values stored as 16-bit signed integers with a scaling factor assigned to each band. The actual radiance values vary from zero to approximately 30,000 (the value zero is used to indicate fill data). Some negative values may exist do to sensor noise. The L1G image files are constructed on a platform which is little-endian; the output data is big-endian.

2.2.2 Ancillary Data Files

For a complete listing of the remaining files included with the HDF product see Table 2-2. These files are described in detail in Section 3.3.

Section 3 Level 1 Output File Formats

3.1 GeoTIFF File Formats

3.1.1 Level 1 Image File

The description of an image in GeoTIFF requires tags and keys as described in the GeoTIFF Specification (Federal Geographic Data Committee (FGDC), Content Standard for Digital Geospatial Metadata, (http://www.fgdc.gov/metadata/contstan.html).). These tags and keys will be included in the level 1 image files and are automatically detected and read by TIFF readers. They are described in the following subsections.

Each image band in the L1G product is provided in a separate file. The data are laid out in a line sequential format in left to right detector order. The L1G product is radiometrically corrected, geometrically resampled, Sensor Chip Assembly (SCA)-stitched, and registered to a geographic map projection. In addition, the L1Gst product has elevation correction applied.

3.1.1.1 GeoTIFF Tags

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

A complete description of the raster data requires georeferencing of the data, which is also accomplished through the use of tags. EO-1 level 1 production system uses the transformation raster and model space tie points and scaling parameters. ModelTiepointTag and ModelPixelScaleTag are used for this purpose.

3.1.1.2 ModelTiepointTag

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

This tag stores the raster-to-model tiepoint pairs in the 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 will be 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.

3.1.1.3 ModelPixelScaleTag

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

This tag is used to specify 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 three values:

ModelPixelScaleTag = (ScaleX, ScaleY, ScaleZ),

where ScaleX and ScaleY give the horizontal and vertical spacing of raster pixels, and ScaleZ is used to map the pixel value of a DEM into the correct Z-scale.

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

3.1.1.4 GeoTIFF Keys

In addition to tags, the description of a projection in GeoTIFF requires the use of keys. The keys necessary to define the projections supported by the L1G production systems, and their possible values, are listed below.

Valid Keys	Possible Values	Meaning
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 (see Applicable Document 7 for values)
	32767	User defined

Table 3-1. GeoTIFF Keys used for defining UTM projection

3.2 HDF File Formats

3.2.1 Level 1 Image File

Each image band in the L1G product is provided in a separate file. The data are laid out in a line sequential format in left to right detector order. The L1G product is radiometrically corrected, geometrically resampled, SCA-stitched, and registered to a geographic map projection. In addition, the L1Gst product has elevation correction applied.

3.2.1.1 HDF Directory File

The directory file contains all the pointers, file size information, and data objects required to open and process the L1G product using the HDF library and interface routines.

3.2.1.2 Vgroup Definitions

The Vgroup structure was designed to associate related HDF data objects. Any HDF data object [e.g., Vdata, scientific data sets (SDSs), and attributes] can be included in an HDF Vgroup definition. Vgroup employs Vgroup names and Vgroup classes for characterizing a collection of data objects and for searching activities. Three classes are recognized for the L1G HDF product: image data, correction data, and metadata. The HDF Vgroup interface consists of routines for accessing and getting information about the L1G product Vgroup. This information is stored in the HDF data directory. The Vgroup used to relate the different data objects that make up a complete L1G product are presented in Table 3-2.

Vgroup Name	Vgroup Class	Object Name	Type	Description
Scene_Data_Pan	Image_Data	EO1spppprrrYYYYDDDXXXML.B01	SDS	ALI band 1 data
Scene_Data_Ref	Image_Data	EO1spppprrrYYYYDDDXXXML.B02	SDS	ALI band 2 data
		EO1spppprrrYYYYDDDXXXML.B03	SDS	ALI band 3 data
		EO1spppprrrYYYYDDDXXXML.B04	SDS	ALI band 4 data
		EO1spppprrrYYYYDDDXXXML.B05	SDS	ALI band 5 data
		EO1spppprrrYYYYDDDXXXML.B06	SDS	ALI band 6 data
		EO1spppprrrYYYYDDDXXXML.B07	SDS	ALI band 7 data
		EO1spppprrrYYYYDDDXXXML.B08	SDS	ALI band 8 data
		EO1spppprrrYYYYDDDXXXML.B09	SDS	ALI band 9 data
		EO1spppprrrYYYYDDDXXXML.B10	SDS	ALI band 10 data
Product_Metadata	Metadata	EO1spppprrrYYYYDDDXXXML.MTL	Vdata	Level 1 product-specific metadata

Table 3-2. Vgroup Definitions: Level 1G Product

3.3 Ancillary Data Files

3.3.1 L1G Metadata File

The level 1 metadata file is created during product generation and contains information specific to the product ordered. Table 3-3 lists the full contents of the L1G metadata file. This file contains all applicable image description information from the level 0 metadata file and the EO-1 Data Processing System (DPS) metadata provided with the L0R product.

Vdata Name: EO1spppprrrYYYYDDDXXXML.MTL
Vdata Class: EPG_Metadata
Interlace Type: FULL_INTERLACE
Number of Records: One record.

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description/Remarks
GROUP	16	= L1_METADATA_FILE	Beginning of first level object description language (ODL) group. It indicates start of L1G metadata file level group
GROUP	18	= METADATA_FILE_INFO	Beginning of metadata file information group
REQUEST_ID	19	USGS products use: "NNNYYMMDDSSSS_UUUUU" format where: NNNYYMMDDSSSS = 13-digit DORRAN order number NNN = Node indicator YY = Year MM = Month DD = Day SSSS = Sequence number for the day UUUUU = 5-digit DORRAN unit number	Data producer-defined request number that uniquely identifies each product. USGS products use a unique product generation request ID generated by DORRAN.
PRODUCT_CREATION_TIME	20	= YYYY-MM-DDThh:mm:ssZ where YYYY = 4-digit year MM = month number of year (01-12) DD = day of month (01-31) T indicates start of time information in ODL ASCII time code format hh = hours (00-23) mm = minutes (00-59) ss = seconds (00-59) Z indicates Zulu time (same as GMT)	L1G system date and time when metadata file for L1G product set was created. For ease of human readability, this date and time are presented in ODL American Standard Code for Information Interchange (ASCII) format. Time is expressed as Universal Time Coordinated (UTC) (also known as Greenwich Mean Time (GMT)). Insertion of additional characters "T" and "Z" is required to meet ODL ASCII format
EO1_XBAND	1	= "1"	EO-1 X-band used to downlink data to LGS
GROUND_STATION	3	= "XXX" where XXX = may be any combination of alfa or numeric characters i.e. PF1 = Poker Flat 1, AK LGS = Landsat Ground Station, SD LXS = Landsat Ground Station, SD SGS = Svalbard Ground Station, Norway AGS = Alaska Ground Station, AK AKS = DataLynx Ground Station, AK WGS = Wallops Ground Station, VA WPS = Wallops Ground Station, VA HGS = Tasmanian Earth Resources Satellite Station (Hobart), Australia	Ground station that received data

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description/Remarks
		GGS = Goddard Ground Station	
DPS_ VERSION_NUMBER	4	= “N.NN”	DPS processing version number
DATEHOUR_CONTACT_PERIOD	7	= YYDOYHH	Date and hour of contact period start
END_GROUP	18	= METADATA_FILE_INFO	End of metadata information group
GROUP	16	= PRODUCT_METADATA	Beginning of product metadata group
PRODUCT_TYPE	5	= “L1GS” = “L1GST”	Identifier to inform user of product type
PROCESSING_SOFTWARE	8	= “SYSTEM_VERSION” where SYSTEM = EPG VERSION = version of software	L1G processing system and software version. Examples: EPG_4.5 EPG_4.3
EPHEMERIS_TYPE	10	= “ACS” = “DEFINITIVE” = “GPS”	Identifier to inform user of orbital ephemeris type used.
SPACECRAFT_ID	3	= “EO1”	Name of satellite platform
SENSOR_ID	3	= “ALI”	Name of imaging sensor
ACQUISITION_DATE	10	= YYYY-MM-DD	Date image was acquired
START_TIME	17	= YYYY DDD HH:MM:SS where YYYY = four digit year DDD = julian day of year (001-366) HH = hour (00-23) MM = minute (00-59) SS = second (00-59)	GMT sensor was turned on
END_TIME	17	= YYYY DDD HH:MM:SS where YYYY = four digit year DDD = julian day of year (001-366) HH = hour (00-23) MM = minute (00-59) SS = second (00-59)	GMT sensor was turned off
BAND_COMBINATION	11	= “NNNNNNNNNNN”, where NNNNNNNNNNN = e.g., 12345678910 for all bands present, 123-------10 for bands 1, 2, 3 and 10. A ‘-’ is a position holder for absent bands	L1G-generated indicator of bands present for product ordered
PRODUCT_UL_CORNER_LAT	11	= -90.0000000 through +90.0000000 degrees (with 7-digit precision) Positive (+) value indicates North latitude; negative (-) value indicates South latitude	Latitude value for upper left corner of product (L1 systems recalculate for 1G product)
PRODUCT_UL_CORNER_LON	12	= -180.0000000 through +180.0000000 degrees (with 7-digit precision) Positive (+) value indicates East longitude; negative (-) value indicates West longitude	Longitude value for upper left corner of product (L1 systems recalculate for 1G product)
PRODUCT_UR_CORNER_LAT	11	= -90.0000000 through +90.0000000 degrees (with 7-digit precision)	Latitude value for upper right corner of product (L1 systems recalculate for 1G product)
PRODUCT_UR_CORNER_LON	12	= -180.0000000 through +180.0000000 degrees (with 7-digit precision)	Longitude value for upper right corner of product (L1 systems recalculate for 1G product)
PRODUCT_LL_CORNER_LAT	11	= -90.0000000 through +90.0000000 degrees (with 7-digit precision)	Latitude value for lower left corner of product (L1 systems recalculate for 1G product)
PRODUCT_LL_CORNER_LON	12	= -180.0000000 through +180.0000000 degrees (with 7-digit precision)	Longitude value for lower left corner of product (L1 systems recalculate for 1G product)
PRODUCT_LR_CORNER_LAT	11	= -90.0000000 through +90.0000000 degrees (with 7-digit precision)	Latitude value for lower right corner of product (L1 systems recalculate for 1G product)
PRODUCT_LR_CORNER_LON	12	= -180.0000000 through +180.0000000 degrees (with 7-digit precision)	Longitude value for lower right corner of product (L1 systems recalculate for 1G product)
PRODUCT_UL_CORNER_MAPX	14	= -132000000.000 through 132000000.000 Units are meters	Projection X coordinate for upper left corner of product (L1 systems

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description/Remarks
			calculated, 1G only)
PRODUCT_UL_CORNER_MAPY	14	= -132000000.000 through 132000000.000 Units are meters	Projection Y coordinate for upper left corner of product (L1 systems calculated, 1G only)
PRODUCT_UR_CORNER_MAPX	14	= -132000000.000 through 132000000.000 Units are meters	Projection X coordinate for upper right corner of product (L1 systems calculated, 1G only)
PRODUCT_UR_CORNER_MAPY	14	= -132000000.000 through 132000000.000 Units are meters	Projection Y coordinate for upper right corner of product (L1 systems calculated, 1G only)
PRODUCT_LL_CORNER_MAPX	14	= -132000000.000 through 132000000.000 Units are meters	Projection X coordinate for lower left corner of product (L1 systems calculated, 1G only)
PRODUCT_LL_CORNER_MAPY	14	= -132000000.000 through 132000000.000 Units are meters	Projection Y coordinate for lower left corner of product (L1 systems calculated, 1G only)
PRODUCT_LR_CORNER_MAPX	14	= -132000000.000 through 132000000.000 Units are meters	Projection X coordinate for lower right corner of product (L1 systems calculated, 1G only)
PRODUCT_LR_CORNER_MAPY	14	= -132000000.000 through 132000000.000 Units are meters	Projection Y coordinate for lower right corner of product (L1 systems calculated, 1G only)
PRODUCT_SAMPLES_PAN	6		Product samples for the panchromatic band (band 1)
PRODUCT_LINES_PAN	6		Product lines for the panchromatic band (band 1)
PRODUCT_SAMPLES_REF	6		Product samples for the reflective bands (bands 2-10)
PRODUCT_LINES_REF	6		Product lines for the reflective bands (bands 2-10)
BAND1_FILE_NAME	30	“EO1spppprrrYYYYDDDXXXML_B01.XXX” (XXX = L1G or TIF)	L1G-generated external element file name for band 1
BAND2_FILE_NAME	30	“EO1spppprrrYYYYDDDXXXML_B02.XXX” (XXX = L1G or TIF)	L1G-generated external element file name for band 2
BAND3_FILE_NAME	30	“EO1spppprrrYYYYDDDXXXML_B03.XXX” (XXX = L1G or TIF)	L1G-generated external element file name for band 3
BAND4_FILE_NAME	30	“EO1spppprrrYYYYDDDXXXML_B04.XXX” (XXX = L1G or TIF)	L1G-generated external element file name for band 4
BAND5_FILE_NAME	30	“EO1spppprrrYYYYDDDXXXML _B05.XXX” (XXX = L1G or TIF)	L1G-generated external element file name for band 5
BAND6_FILE_NAME	30	“EO1spppprrrYYYYDDDXXXML _B06.XXX” (XXX = L1G or TIF)	L1G-generated external element file name for band 6
BAND7_FILE_NAME	30	EO1spppprrrYYYYDDDXXXML_B07.XXX” (XXX = L1G or TIF)	L1G-generated external element file name for band 7
BAND8_FILE_NAME	30	“EO1spppprrrYYYYDDDXXXML_B08.XXX” (XXX = L1G or TIF)	L1G-generated external element file name for band 8
BAND9_FILE_NAME	30	“EO1spppprrrYYYYDDDXXXML_B09.XXX” (XXX = L1G or TIF)	L1G-generated external element file name for band 9
BAND10_FILE_NAME	30	“EO1spppprrrYYYYDDDXXXML_B10.XXX” (XXX = L1G or TIF)	L1G-generated external element file name for band 10
METADATA_L1_FILE_NAME	30	“EO1spppprrrYYYYDDDXXXML_MTL.XXX” (XXX = L1G, TIF)	L1G-generated external element file name for L1G metadata
CPF_FILE_NAME	27	“EO1ACPFYYYYMMDD_YYYYMMDD.nn” where YYYYMMDD = effective start date and effective end date, respectively.nn = incrementing version number within a 90-day period (00-99)	Archive-generated external element file name for Calibration Parameter File.
HDF_DIR_FILE_NAME	32	“EO1spppprrrYYYYDDDXXXML _HDF.XXX” (XXX = L1G)	L1G-generated file name for HDF directory file (HDF products only)
END_GROUP	16	= PRODUCT_METADATA	End of product metadata group
GROUP	16	= RADIANCE_SCALING	Beginning of the radiance scaling group
BAND1_SCALING_FACTOR	7	= N.NNNNN	Scaling factor used to convert calibrated DN to Radiance units for band 1. (W/(m^2 sr um).
BAND2_SCALING_FACTOR	7	= N.NNNNN	Scaling factor used to convert calibrated DN to Radiance units for

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description/Remarks
			band 2. (W/(m^2 sr um).
BAND3_SCALING_FACTOR	7	= N.NNNNN	Scaling factor used to convert calibrated DN to Radiance units for band 3. (W/(m^2 sr um).
BAND4_SCALING_FACTOR	7	= N.NNNNN	Scaling factor used to convert calibrated DN to Radiance units for band 4. (W/(m^2 sr um).
BAND5_SCALING_FACTOR	7	= N.NNNNN	Scaling factor used to convert calibrated DN to Radiance units for band 5. (W/(m^2 sr um).
BAND6_SCALING_FACTOR	7	= N.NNNNN	Scaling factor used to convert calibrated DN to Radiance units for band 6. (W/(m^2 sr um).
BAND7_SCALING_FACTOR	7	= N.NNNNN	Scaling factor used to convert calibrated DN to Radiance units for band 7. (W/(m^2 sr um).
BAND8_SCALING_FACTOR	7	= N.NNNNN	Scaling factor used to convert calibrated DN to Radiance units for band 8. (W/(m^2 sr um).
BAND9_SCALING_FACTOR	7	= N.NNNNN	Scaling factor used to convert calibrated DN to Radiance units for band 9. (W/(m^2 sr um).
BAND10_SCALING_FACTOR	7	= N.NNNNN	Scaling factor used to convert calibrated DN to Radiance units for band 10. (W/(m^2 sr um).
BAND1_OFFSET	5	= NN.NN	Additive scaling factor used to convert calibrated DN to Radiance units for Band 1. (W/(m^2 sr um).
BAND2_OFFSET	5	= NN.NN	Additive scaling factor used to convert calibrated DN to Radiance units for Band 2. (W/(m^2 sr um).
BAND3_OFFSET	5	= NN.NN	Additive scaling factor used to convert calibrated DN to Radiance units for Band 3. (W/(m^2 sr um).
BAND4_OFFSET	5	= NN.NN	Additive scaling factor used to convert calibrated DN to Radiance units for Band 4. (W/(m^2 sr um).
BAND5_OFFSET	5	= NN.NN	Additive scaling factor used to convert calibrated DN to Radiance units for Band 5. (W/(m^2 sr um).
BAND6_OFFSET	5	= NN.NN	Additive scaling factor used to convert calibrated DN to Radiance units for Band 6. (W/(m^2 sr um).
BAND7_OFFSET	5	= NN.NN	Additive scaling factor used to convert calibrated DN to Radiance units for Band 7. (W/(m^2 sr um).
BAND8_OFFSET	5	= NN.NN	Additive scaling factor used to convert calibrated DN to Radiance units for Band 8. (W/(m^2 sr um)
BAND9_OFFSET	5	= NN.NN	Additive scaling factor used to convert calibrated DN to Radiance units for Band 9. (W/(m^2 sr um).
BAND10_OFFSET	5	= NN.NN	Additive scaling factor used to convert calibrated DN to Radiance units for Band 10. (W/(m^2 sr um).
END_GROUP	16	= RADIANCE_SCALING	End of radiance scaling group.
GROUP	18	= PRODUCT_PARAMETERS	Beginning of product parameters group
CORRECTION_METHOD_GAIN_BAND1	3	= “CPF” (for CPF gains) = “IC” (for IC gains)	Correction method used by L1G in creating image for band 1
CORRECTION_METHOD_GAIN_BAND2	3	= “CPF” (for CPF gains) = “IC” (for IC gains)	Correction method used by L1G in creating image for band 2
CORRECTION_METHOD_GAIN_BAND3	3	= “CPF” (for CPF gains) = “IC” (for IC gains)	Correction method used by L1G in creating image for band 3
CORRECTION_METHOD_GAIN_BAND4	3	= “CPF” (for CPF gains) = “IC” (for IC gains)	Correction method used by L1G in creating image for band 4

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description/Remarks
CORRECTION_METHOD_GAIN_BAND5	3	= “CPF” (for CPF gains) = “IC” (for IC gains)	Correction method used by L1G in creating image for band 5
CORRECTION_METHOD_GAIN_BAND6	3	= “CPF” (for CPF gains) = “IC” (for IC gains)	Correction method used by L1G in creating image for band 6
CORRECTION_METHOD_GAIN_BAND7	3	= “CPF” (for CPF gains) = “IC” (for IC gains)	Correction method used by L1G in creating image for band 7
CORRECTION_METHOD_GAIN_BAND8	3	= “CPF” (for CPF gains) = “IC” (for IC gains)	Correction method used by L1G in creating image for band 8
CORRECTION_METHOD_GAIN_BAND9	3	= “CPF” (for CPF gains) = “IC” (for IC gains)	Correction method used by L1G in creating image for band 9
CORRECTION_METHOD_GAIN_BAND10	3	= “CPF” (for CPF gains) = “IC” (for IC gains)	Correction method used by L1G in creating image for band 10
CORRECTION_METHOD_BIAS	3	= “CPF” (for CPF gains) = “IC” (for IC gains)	Correction method used by L1G in creating image
SENSOR_LOOK_ANGLE	11	= -90.00000 through 90.00000 degrees (with 5-digit precision) A positive value indicates sensor pointing east. A negative value (-) indicates sensor pointing west. Leading zeros not required = “UNAVAILABLE” (not calculated)	Sensor look angle in degrees with the nadir look equal to zero.
SUN_AZIMUTH	12	= -180.0000000 through 180.0000000 degrees (with 7-digit precision) A positive value indicates angles to the east or clockwise from north. A negative value (-) indicates angles to the west or counterclockwise from north. Leading zeros are not required. = “UNAVAILABLE” (not calculated)	Sun azimuth angle in degrees for image center location at image center acquisition time
SUN_ELEVATION	11	= -90.0000000 through 90.0000000 degrees (with 7-digit precision) A positive value indicates a daytime scene. A negative value (-) indicates a nighttime scene. Leading zeros are not required. = “UNAVAILABLE” (not calculated)	Sun elevation angle in degrees for image center location at image center acquisition time
OUTPUT_FORMAT	10	= “FORMAT_VERSION” where FORMAT = HDF, GEOTIFF VERSION = output format version	Output format and output format version of image. Examples: HDF_4.1r5 GEOTIFF NOTE: no version included for GEOTIFF
END_GROUP	18	= PRODUCT_PARAMETERS	End of product parameters group
GROUP	19	= CORRECTIONS_APPLIED	Beginning of corrections applied group
COHERENT_NOISE	1	= “Y” or “N”	Indicator of whether image was corrected for coherent noise
INOPERABLE_DETECTORS	1	= “Y” or “N”	Indicator of whether image was corrected for inoperable detectors
LEAKY PIXEL	1	= “Y” or “N”	Indicator of whether image was corrected for leaky pixels
STRIPING	1	= “Y” or “N”	Indicator of whether image was corrected for striping
ELEVATION_SOURCE	7	= “N” (no correction applied) = “SRTM-2” (1 Arc Sec) = “SRTM-1” (3 Arc Sec) = “NED” = “DTED” = “GTOPO30”	Indicates the source (if any) of Digital Elevation Model (DEM) used in the correction process.
END_GROUP	19	= CORRECTIONS_APPLIED	End of corrections applied group
GROUP	21	= PROJECTION_PARAMETERS	Beginning of projection parameters group (1G product only)
REFERENCE_DATUM	8	= “WGS84”	Datum used in creating image
REFERENCE_ELLIPSOID	8	= “WGS84”	Ellipsoid used in creating image
GRID_CELL_SIZE_PAN	5	= 7.50 through 15.00 meters, in increments of 0.01 meters	Grid cell size used in creating image for pan band, if part of product

Parameter Name	Size*	Value, Format, Range, and Units	Parameter Description/Remarks
GRID_CELL_SIZE_REF	5	=15.00 through 30.00 meters, in increments of 0.01 meters	Grid cell size used in creating image for Visible and Near Infrared (VNIR)/ Short-Wave Infrared (SWIR) bands, if part of product
ORIENTATION	3	= “NUP” North Up	Orientation used in creating image
RESAMPLING_OPTION	3	= “NN” Nearest Neighbor = “CC” Cubic Convolution = “MTF” Modulation Transfer Function	Resampling option used in creating image
MAP_PROJECTION	3	= “UTM” Universal Transverse Mercator	Map projection used in creating image
END_GROUP	21	= PROJECTION_PARAMETERS	End of projection parameters group
Projection parameters data (not a Level 1 metadata parameter)			**The following parameters are included only with products that select a map projection of UTM**
GROUP	14	UTM_PARAMETERS	Beginning of UTM parameters group
ZONE_NUMBER	3	= 1 to 60 or -1 to -60	Value used to indicate zone number. “-“signifies zones south of the equator.
END_GROUP	14	UTM_PARAMETERS	End of UTM parameters group
END_GROUP	16	L1_METADATA_FILE	End of Level 1 metadata file level group
END			Required standalone parameter signifying file end
*ASCII bytes			

Table 3-3. Level 1 Metadata File

3.3.2 FGDC Metadata File

The FGDC Metadata file contains metadata information about the ALI scene in a standard format as described in *Content Standard for Digital Geospatial Metadata* (See References Section). The FGDC Metadata file does not contain information specific to the processing of the L1G image that the L1G Metadata file will include.

Section 4 Product Packaging

L1G products are available on Digital Versatile Disk - Recordable (DVD-R) and via electronic transfer. The following sections provide information on each of the distribution methods for the available L1G product formats.

4.1 DVD-R

Data products on DVD-R are mastered using International Standards Organization (ISO) 9660 Interchange level 2, the International standard for file formatting a DVD-R. No file unpacking is required; the files are ready for processing using HDF or other software tools. DVD-R products are mastered using single sided, single layered technology providing a capacity of 2.1 gigabytes. This configuration will be compatible with most DVD-ROM readers.

The root directory contains a readme file, which describes product content.

The DVD-R label will include the following information: processing level (e.g., Level 1Gs, L1Gst, L1Gt); product format (e.g., HDF or GeoTIFF); Distributed Ordering Research Reporting and Accounting Network (DORRAN) order number; DORRAN unit number; DVD-R volume number; scene ID; mission indicator (which is EO-1 ALI); and the USGS logo. Corner coordinates may be included if space permits. The target path, row, and acquisition date information is supplied through the format of the naming convention of the base part of file names and the subdirectory (as defined in Section 2 as part of the scene ID).

4.2 Electronic Transfer

Products available via electronic transfer will also include the L1G volume descriptor (readme file) with the same filenames as listed above. Electronic data transfer products use UNIX File Transfer Protocol (FTP). FTP, as described in Request for Comments (RFC) 959, is an Internet standard for file transfer that supports retrieval of files from a remote server. This distribution method may not be available to all end users by all distribution systems. In some cases special high-speed network requirements must be arranged. Various strategies and procedures to access data may vary significantly between distribution systems.

When FTP service is available, data will be stored using the following standard. The home or initial login directory contains a set of files. All files for an order will be in a home directory. ALI products available via FTP will be compressed (tarred and zipped). The FTP instructions e-mailed to the customer at the time the data is posted to the FTP site will contain directions for uncompressing the data.

Appendix A Projection Parameters

Projection Name Mnemonic	Array Element							
	1	2	3	4	5	6	7	8
UTM	Lon/Z	Lat/Z						

Table A-1. USGS Projection Parameters – Projection Transformation Package Projection Parameters

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

Table A-3. USGS Projection Parameters Key

NOTES: 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 Abbreviations and Acronyms

AC	(Linear Etalon Imaging Spectrometer Array) Atmospheric Corrector
ACS	Attitude Control System
AEA	Albers Equal Area
ALI	Advanced Land Imager
ASCII	American Standard Code for Information Interchange
CCB	Configuration Control Board
CCR	Configuration Change Request
CD-ROM	Compact Disc Read-Only Memory
CPF	Calibration Parameter File
DCPF	Data Capture and Processing Facility
DEM	Digital Elevation Model
DFCB	Data Format Control Book
DORRAN	Distributed Ordering Research Reporting and Accounting Network
DPS	Data Processing System
DPSRT	Data Processing System Real Time
DVD-R	Digital Versatile Disk - Recordable
EO-1	Earth Observing-1
EPG	EO-1 Product Generation
EPSG	European Petroleum Survey Group
EROS	Earth Resources Observation and Science
ESDIS	Earth Science Data and Information System
ETM+	Enhanced Thematic Mapper Plus
FGDC	Federal Geographic Data Committee
FTP	File Transfer Protocol
F&PRS	Functional and Performance Requirements Specification
GCP	Ground Control Point
GeoTIFF	Geographic Tagged Image File Format
GMT	Greenwich Mean Time
GPS	Global Positioning System

GSFC	Goddard Space Flight Center
HDF	Hierarchical Data Format
IC	Internal Calibrator
ICD	Interface Control Document
I/O	Input/Output
ISO	International Standards Organization
JPL	Jet Propulsion Laboratory
L0	Level 0
L0Ra	Level 0 Reformatted Archive
L0Rp	Level 0 Reformatted Product
L1	Level 1
L1G	Level 1 Geometrically Corrected
L1Gs	Level 1 Geometric Systematically Corrected
L1Gst	Level 1 Geometric Systematic Terrain Corrected
L1R	Level 1 Radiometrically Corrected
L1Gt	Level 1 Terrain Corrected
LASP	Laboratory for Atmospheric and Space Physics
LGS	Landsat Ground System
m	Meter
mm	Millimeter
Mbps	Megabits Per Second
MTL	Metadata Level 1
N/A	Not Applicable
NASA	National Aeronautics and Space Administration
ODL	Object Description Language
RFC	Request For Comments
SCA	Sensor Chip Assembly
SOM	Space Oblique Mercator
SWIR	Short-Wave Infrared
TIFF	Tagged Image File Format
USGS	United States Geological Survey

UTC	Universal Time Coordinated
UTM	Universal Transverse Mercator
VNIR	Visible and Near Infrared
WRS	Worldwide Reference System

References

The following documents provide additional detail and reference information regarding the format of the Level 1 output files.

U.S. Geological Survey (USGS)/EROS Data Center (EDC), LPS-112-1, Landsat 7 System Zero-R Distribution Product Data Format Control Book, Volume 5, Book 1, Revision 6, October 1999.

U.S. Geological Survey (USGS)/EROS Data Center (EDC), L7-DFCB-04.6, Landsat 7 ETM+ Level 1 Product Output Files Data Format Control Book (DFCB), Version 6, April 2004.

GeoTIFF Specification, Revision 1.0
(http://www.remotesensing.org/geotiff/spec/geotiffhome.html)

Jet Propulsion Laboratory, California Institute of Technology, Object Description Language Specification and Usage, Chapter 12 of Planetary Data System Standards Reference, Version 3.2, July 24, 1995 (http://pds.jpl.nasa.gov/stdref/chap12.htm)

Federal Geographic Data Committee (FGDC), Content Standard for Digital Geospatial Metadata, (http://www.fgdc.gov/metadata/contstan.html).