CLEMENTINE EDR IMAGE SIS

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1. INTRODUCTION

1.1 PURPOSE

This Software Interface Specification (SIS) describes the organization and contents of the Clementine EDR (Experimental Data Record) Image data products. There are six cameras onboard the Clementine spacecraft that will produce image data: 1) A-Star-tracker camera (A-STAR), 2) B-Star-tracker camera (B-STAR), 3) LIDAR High-resolution camera (HiRes), 4) ultraviolet / Visible camera (UVVIS), 5) Near Infrared camera (NIR), and 6) the Long Wavelength Infrared Camera (LWIR). The Clementine EDR Data products are deliverable products to the Planetary Data System and the scientific community that it supports. All data formats are based on the PDS standard, version 3.0, as documented in the PDS Standards Reference [JPL Document D-7669, November 1992, available through the PDS].

1.2 SCOPE

This specification is useful to those who wish to understand the format and content of the Clementine EDR Image data products. Typically, these individuals include software engineers, data analysts, and planetary scientists. The SIS applies to the EDR data products produced during the course of Clementine Mission operations.

1.3 APPLICABLE DOCUMENTS

The Clementine EDR SIS is responsive to the following Documents:

<> NASA Research Announcement, Science Team for the Clementine Mission Deep Space Program Science Experiment (DSPSE), January 1993, NRA-93-OSSA-2.

<> DSPSE Experiment Manifest, Naval Center for Space Technology, May 1993 SSD-D-DS-018

<> Planetary Data System Standards Reference, 1992, JPL D-7669. Distributed by the Planetary Data System, Jet Propulsion Laboratory

<> Planetary Science Data Dictionary Document, 1992, JPL D-7116. Distributed by the Planetary Data System, Jet Propulsion Laboratory

1.4 FUNCTIONAL DESCRIPTION

1.4.1 DATA CONTENT SUMMARY

Each Clementine EDR data product consists of a single camera observation. The image data have been depacketized and reformatted with standard PDS labels, but are otherwise "raw". Raw data contain the geometric and radiometric characteristics of unprocessed and unrectified data. To make full utilization of the data, it is necessary to perform radiometric and geometric processing on the data products.

The imaging sensors are framing cameras using CCD technology. The Star tracking cameras (A-STAR and B-STAR) are used for spacecraft navigation and orientation. The science observation cameras (UVVIS, HIRES, NIR, and LWIR) acquire images in a wide spectral range from 415 to 8750 nanometers. The UVVIS, HIRES, and NIR cameras have filter wheels that allow images to be acquired under six spectral filters. The LWIR camera has a single spectral filter. Table 1 shows the pixel dimensions of the images acquired by each camera and the center wavelength of each filter wheel position. Other than the image dimensions, the data products of each camera are identically formatted.

TABLE-1 Characteristics of each camera showing the dimension of an image in lines (rows) and samples (columns), the number of filter wheel positions, and the center wavelength of each filter.

Camera	Lines	Samps	filt	Wavelength(Nanometers)
UVVIS	288	384	6	415,750,900,950,1000,650(broadband)
NIR	256	256	6	1100,1250,1500,2000,2600,2780
LWIR	128	128	1	8750
HIRES	288	384	6	415,560,650,750,650(broadband), opaque
A-STAR	576	384	N/A	(broad band, no filter wheel)
B-STAR	576	384	N/A	(broad band, no filter wheel)

1.4.2 DATA SOURCE AND TRANSFER METHOD

Clementine imaging data products are produced by the Clementine Mission Operations Center operated by the Naval Research Laboratory (NRL). The "NRL-ACT-MGRAB" software converts the data to the proper PDS labeled format.

1.4.3 DATA RECIPIENTS AND UTILIZATION

The Clementine EDR data products are made available to NRL scientists and the NASA/Clementine Science team for initial evaluation and validation. At the end of the evaluation and validation period, the data are organized and stored on compact disc (CD) media and made available to the PDS for distribution to the science community. These products will be used for engineering support, direct science analysis, and construction of other science products.

1.5 ASSUMPTIONS AND CONSTRAINTS

The Clementine EDR data products contain compressed image data. Decompression will result in a raw image that is not corrected for instrument signature, effects of spacecraft motion, or effects of imaging geometry. Although there is enough information in the header to perform some processing, for more sophisticated processing, ancillary data will be required. Examples of ancillary files are calibration files, viewing geometry files, (e.g. SPICE kernels), image index tables, etc.

2. ENVIRONMENT

The Clementine EDR data products are stored on CD media according to the ISO 9660 Volume and Directory Standard. This standard is compatible on virtually all modern hardware platforms including UNIX, IBM/PC, and Macintosh computer environments.

The file headers contained on the Clementine CD-ROMs do not include extended attribute records (XAR). This means that VAX/VMS systems can not readily access the files. Without XARs, record attributes can not be associated with a file. VAX/VMS directory listings of these files will show "Record Attributes: None, Record Format: None" file characteristics.

3. ACCESS

The primary barrier or access to the Clementine EDR data products is the compressed format of the image data. Thus, decompression software is available on the archive to perform decompression. This software produces decompressed image files in a standard PDS format. The software will run on a variety of computer platforms.

4. DETAILED INTERFACE SPECIFICATIONS

4.1 DATA PRODUCT IDENTIFICATION

Each product will have a file name of the form "msfxxxxy.rrr". The file name is unique across all Clementine EDR data products. For more information on the file name refer to the PRODUCT_ID keyword definition in section 4.3.2. The product also contains a data set id that identifies the data set. For more information on the data set id see the DATASET_ID keyword definition in section 4.3.2.

4.2 STRUCTURE AND ORGANIZATION OVERVIEW

The Clementine EDR data products are constructed according to the data object concepts developed by the PDS. By adopting the PDS format, the Clementine EDR images are consistent in content and organization with other planetary image collections. In the PDS standard, the EDR image file is grouped into objects with PDS labels describing the objects. The Clementine EDR data products contain 1) an image object (the primary data), 2) a browse image object, and 3) an image histogram object. The image object contains the observed image data. The image data will exist in a compressed form (if the data are compressed on board the spacecraft), or an uncompressed form (if the data are not compressed on the spacecraft). The browse image object contains an uncompressed image of the original data that has been reduced in size by subsampling the image array. The browse image provides the capability to rapidly view the image collection at a reduced format. The image histogram object contains the histogram of the image after decompression. The image histogram object can be used to obtain statistical information about the image.

A description of the data compression coefficients used on the Clementine images is described in Appendix II.

4.3 PDS LABEL STRUCTURE DEFINITION AND FORMAT

The label area of the data file conforms to the PDS version 3 standards. For more information on this standard consult the PDS Standards Reference JPL D-7669 Document. The purpose of the PDS label is to describe the data product and provide ancillary information about the data product. An example of a PDS label is shown below:

EXAMPLE PDS LABEL FOR THE CLEMENTINE EDR DATA PRODUCTS

```
PDS_VERSION_ID   = PDS3
/*** FILE FORMAT ***/
RECORD_TYPE      = UNDEFINED
/*** POINTERS TO START BYTE OFFSET OF OBJECTS IN FILE ***/
^IMAGE_HISTOGRAM = 4788  <BYTES>
^BROWSE_IMAGE    = 5812  <BYTES>
^IMAGE           = 7540  <BYTES>
/*** GENERAL DATA DESCRIPTION PARAMETERS ***/
MISSION_NAME     = "DEEP SPACE PROGRAM SCIENCE EXPERIMENT"
SPACECRAFT_NAME  = "CLEMENTINE 1"
DATA_SET_ID      = "CLEM1-L/E/Y-A/B/U/H/L/N-2-EDR-V1.0"
PRODUCT_ID       = "LUC0538B.032"
ORIGINAL_PRODUCT_ID = "LUC00538.032"
PRODUCER_INSTITUTION_NAME = "NAVAL RESEARCH LABORATORY"
PRODUCT_TYPE     = EDR
EDR_SOFTWARE_NAME  = "NRL-ACT-MGRAB V1.2"
MISSION_PHASE_NAME = "LUNAR MAPPING"
DATA_QUALITY_ID    = "N/A"
TARGET_NAME        = "MOON"
REVOLUTION_NUMBER  = 032
FRAME_SEQUENCE_NUMBER = 0538
/*** TIME PARAMETERS ***/
START_TIME = 1994-02-26T21:14:57.857Z
STOP_TIME  = "N/A"
UNCORRECTED_START_TIME = 1994-02-26T21:14:57.859Z
SPACECRAFT_CLOCK_START_COUNT = "N/A"
SPACECRAFT_CLOCK_STOP_COUNT  = "N/A"
PRODUCT_CREATION_TIME        = 1994-09-30T19:53:05
/*** CAMERA RELATED PARAMETERS ***/
INSTRUMENT_NAME   = "ULTRAVIOLET/VISIBLE CAMERA"
INSTRUMENT_ID     = "UVVIS"
FILTER_NAME       = "C"
CENTER_FILTER_WAVELENGTH = 900 <nm>
BANDWIDTH         = 20 <nm>
GAIN_MODE_ID      = "2"
MCP_GAIN_MODE_ID  = "N/A"
OFFSET_MODE_ID    = "3"
EXPOSURE_DURATION = 7.9296   <ms>
LENS_TEMPERATURE  =  267.63   <K>
FOCAL_PLANE_TEMPERATURE = 271.802  <K>
CRYOCOOLER_TEMPERATURE  = "N/A"
```

```
CRYOCOOLER_DURATION = "N/A"
/*** J2000 (ALSO CALLED EME2000) IS THE INERTIAL REFERENCE SYSTEM   ***/
/*** USED TO SPECIFY OBSERVATIONAL GEOMETRY. LATITUDE AND LONGITUDE ***/
/*** COORDINATES OF TARGET ARE PLANETOCENTRIC. GEOMETRIC PARAMETERS ***/
/*** ARE BASED ON BEST AVAILABLE DATA AT TIME OF PRODUCT CREATION.  ***/
/*** REFER TO CLEMENTINE SPICE DATA BASE FOR THE MOST CURRENT       ***/
/*** OBSERVATIONAL GEOMETRY DATA.                                   ***/
/*** LINE-OF-SITE ON CELESTIAL SPHERE: Angles in <deg> ***/
RIGHT_ASCENSION  = 238.60  <deg>
DECLINATION      = 61.62   <deg>
TWIST_ANGLE      = 300.70  <deg>
RETICLE_POINT_RA = ( 231.53, 237.89, 245.09, 239.49)
RETICLE_POINT_DECLINATION = (  62.77,  58.14,  60.12,  65.09)
/*** OBSERVATIONAL SEQUENCE INFORMATION ***/
SEQUENCE_TABLE_ID = "CEQ_03"
/*** TARGET PARAMETERS: Position <km>, Velocity <km/s> ***/
SC_TARGET_POSITION_VECTOR = (      -575.6,      -954.2,      2049.3)
SC_TARGET_VELOCITY_VECTOR = ( -1.4890,  0.2342, -0.7037)
TARGET_CENTER_DISTANCE    = 2332.7      <km>
/*** TARGET WITHIN SENSOR FOV: Angles in <deg> ***/
SLANT_DISTANCE   = 595.3       <km>
CENTER_LATITUDE  = -74.39  <deg>
CENTER_LONGITUDE = 11.00   <deg>
HORIZONTAL_PIXEL_SCALE = 0.152 <km>
VERTICAL_PIXEL_SCALE   = 0.152 <km>
SMEAR_MAGNITUDE  = 0.07   <pixels>
SMEAR_AZIMUTH    = 89.80   <deg>
NORTH_AZIMUTH    = 270.51  <deg>
RETICLE_POINT_LATITUDE  = ( -75.08, -75.09, -73.66, -73.64)
RETICLE_POINT_LONGITUDE = (  14.76,   7.29,   7.57,  14.39)
/*** SPACECRAFT POSITION WITH RESPECT TO CENTRAL BODY ***/
SUB_SPACECRAFT_LATITUDE  = -74.38  <deg>
SUB_SPACECRAFT_LONGITUDE = 10.74   <deg>
SPACECRAFT_ALTITUDE    = 595.3    <km>
SUB_SPACECRAFT_AZIMUTH = 347.12  <deg>
/*** SPACECRAFT LOCATION: Position <km>, Velocity <km/s> ***/
SPACECRAFT_SOLAR_DISTANCE = 148497945.3
SC_SUN_POSITION_VECTOR    = (-137837390.0,  50702496.3,  21948816.2)
SC_SUN_VELOCITY_VECTOR    = (-10.2690,-26.6845,-10.7240)
/*** VIEWING AND LIGHTING GEOMETRY (SUN ON TARGET) ***/
SOLAR_DISTANCE   = 148498461.7 <km>
SUB_SOLAR_AZIMUTH   = 295.12  <deg>
SUB_SOLAR_LATITUDE  = 1.53    <deg>
SUB_SOLAR_LONGITUDE = 346.24  <deg>
INCIDENCE_ANGLE  = 77.38   <deg>
PHASE_ANGLE      = 77.21   <deg>
EMISSION_ANGLE   = 0.28    <deg>
LOCAL_HOUR_ANGLE = 208.08  <deg>
/*** LIGHTING GEOMETRY FROM SECONDARY SOURCE ***/
LIGHT_SOURCE_NAME     = "EARTH"
LIGHT_SOURCE_DISTANCE = 362703.5    <km>
SUB_LIGHT_SOURCE_AZIMUTH   = 283.08  <deg>
SUB_LIGHT_SOURCE_LATITUDE  = 6.08    <deg>
SUB_LIGHT_SOURCE_LONGITUDE = 357.76  <deg>
LIGHT_SOURCE_INCIDENCE_ANGLE = 81.16   <deg>
LIGHT_SOURCE_PHASE_ANGLE   = 81.04   <deg>
/*** DESCRIPTION OF OBJECTS CONTAINED IN THE FILE ***/
OBJECT = IMAGE_HISTOGRAM
  ITEMS      = 256
  DATA_TYPE  = LSB_INTEGER
```

```
  ITEM_BYTES = 4
END_OBJECT
OBJECT = BROWSE_IMAGE
  LINES           = 36
  LINE_SAMPLES    = 48
  SAMPLING_FACTOR = 8
  SAMPLE_TYPE   = UNSIGNED_INTEGER
  SAMPLE_BITS   = 8
END_OBJECT
OBJECT = IMAGE
  ENCODING_TYPE = "CLEM-JPEG-1"
  ENCODING_COMPRESSION_RATIO = 3.05
  LINES        = 288
  LINE_SAMPLES = 384
  SAMPLE_TYPE  = UNSIGNED_INTEGER
  SAMPLE_BITS  = 8
  MAXIMUM  = 255
  MINIMUM  = 27
  MEAN     = 119.269
  STANDARD_DEVIATION = 48.200
  CHECKSUM = 4816272
END_OBJECT
END
```

4.3.1 GEOMETRIC AND VIEWING PARAMETER ASSUMPTIONS

Table 2 lists the computational assumptions for the geometric and viewing data provided in the PDS label. There are two coordinate systems in use: 1) the celestial reference system used for target and spacecraft position and velocity vectors, and camera pointing; and 2) the planetary coordinate system for geometry vectors and target location. The celestial coordinate system is J2000 (Mean of Earth equator and equinox of J2000). The planetary coordinate system is planetocentric.

TABLE 2. - COMPUTATIONAL ASSUMPTIONS

<> The mid-point time of observation is used for the geometric element computations.

<> Label parameters reflect observed, not true, geometry. Therefore, light-time and stellar aberration corrections are used as appropriate.

<> The inertial reference frame is J2000 (also called EME2000).

<> Latitudes and longitudes are planetocentric.

<> The "sub-point" of a body on a target is defined by the surface intercept of the body-to-target-center vector. This is not the closest point on the body to the observer. This definition gives sub-point latitude and longitude that are independent of the reference ellipsoid.

<> Distances are in km, speeds in km/sec, angles, in degrees, angular rates in degrees/sec, unless otherwise noted.

<> Angle ranges are 0 to 360 degrees for azimuths and local hour

angle. Longitudes range from 0 to 360 degrees (positive to the East). Latitudes range from -90 to 90 degrees.

<> Spice kernel files used in the geometric parameters is outlined in **Appendix I**.

4.3.2 PDS KEYWORD DEFINITIONS

The keywords are listed in the order in which they appear in the example label shown above.

PDS_VERSION_ID = PDS3
The PDS_VERSION_ID data element represents the version number of the PDS standards documents that is valid when a data product label is created. PDS3 is used for the Clementine Data products.

RECORD_TYPE = UNDEFINED
The record_type element indicates the record format of a file. The value UNDEFINED is used in the Clementine EDR data products. There are no record attributes associated with the file. The file can be thought of as a continuous stream of bytes with no record separators.

^IMAGE_HISTOGRAM = xxxxx <BYTES>
The image_histogram is a pointer to the image histogram object. The value contains the starting byte position in the file. (Pointers in the PDS standard assume the first byte in the array is byte position 1.)

^BROWSE_IMAGE = xxxxx <BYTES>
The parameter is the pointer to the browse image object. The value contains the starting byte position in the file. The browse image is an uncompressed sub-sampled image of the image contained in the IMAGE object.

^IMAGE = xxxx <BYTES>
The parameter is the pointer to the image object. The value contains the starting byte position in the file.

MISSION_NAME = "DEEP SPACE PROGRAM SCIENCE EXPERIMENT"
The mission_name element identifies a major planetary mission or project. A given planetary mission may be associated with one or more spacecraft.

SPACECRAFT_NAME = "CLEMENTINE 1"
The spacecraft_name element provides the full, unabbreviated name of the spacecraft.

DATA_SET_ID = "CLEM1-/L/E/Y-A/B/U/H/L/N-2-EDR-V1.0"
The data_set_identification element uniquely identifies the data sets available on the volume. The EDR collection is made up of a single data set.
Targets include: L=Earth's Moon, E=Earth, Y=Sky,
Cameras include: A=A star tracker, B=B star tracker,
U=UV/Vis, H=HiRes, L=longwave infrared,

```
                  N=Nir infrared cameras.

PRODUCT_ID = "msfxxxxy.rrr"
     The product_id data element represents a permanent, unique
     identifier assigned to a data product by its producer.
     The product_id is identical to the name of the EDR image file.
     Where: m = Mission Phase
                P = Prelaunch
                L = Lunar mapping
                E = Earth mapping (LEO and phasing loops)
                A = First earth-moon orbital phasing loops
                B = Second earth-moon orbital phasing loops.
            s = Sensor
                A = Star tracker A
                B = Star tracker B
                U = UV/Vis
                H = Hi-Resolution sensor
                N = Near infrared sensor
                L = Long wavelength infrared sensor
            f = Filter wheel position (A, B, C, D, E, F)
            xxxx = Frame number within revolution
            y = Latitude bin for lunar mapping observations. This
                character signifies a latitude range on the lunar
                surface where the observation was made. The
                center latitude of the image defines the character:
                A = -90 to -80      M = 30 to 40
                B = -80 to -70      N = 40 to 50
                C = -70 to -60      O = 50 to 60
                D = -60 to -50      P = 60 to 70
                E = -50 to -40      Q = 70 to 80
                F = -40 to -30      R = 80 to 90
                G = -30 to -20
                H = -20 to -10      S = "unkown" targets
                I = -10 to   0
                J =   0 to  10      T = Earth observations prior to
                K =  10 to  20          systematic mapping
                L =  20 to  30      U = Sky observations prior to
                                        systematic mapping
                                    V = Lunar observations prior to
                                        systematic mapping
                                    W = Sky observations after
                                        systematic mapping
                                    Y = Earth observations after
                                        systematic mapping
                                    Z = Moon Observations after
                                        systematic mapping


            rrr  = Revolution number (lunar mapping phase)

            For non-lunar mapping phase of the mission, the string
            "xxxxy.rrr" takes on a different meaning:
            rrr = Data down load (dump) number within the mission
                  phase. The image data is periodically downloaded
                  from the spacecraft's solid state data recorder. This
                  field specifies a sequence number, starting with 1, of
                  a download sequence.
            xxxx = Image sequence number of within the download.
            y =   This field contains an alpha character A-Z. The
```

letter increases to the next alpha character after each 100 images. This letter helps limit the number of images that go into each subdirectory on the CD-ROM.

ORIGINAL_PRODUCT_ID = "msfxxxxx.rrr"

During active flight operations, the images were assigned temporary file names and product id's. This keyword contains the temporary product_id (and file name) given to the image. This field should be ignored by all new users of the Clementine data products. The format is similar to the PRODUCT_ID. The '**xxxxx**' field represents a sequence number. There were several problems associated with this number. The sequence numbers refer to the order in which the data were send down from the spacecraft and not the order in which the images were acquired in orbit. Due to ground processing problems, the sequence numbers in the original product id have been shown to be unreliable.

PRODUCER_INSTITUTION_NAME = "NAVAL RESEARCH LABORATORY"

Organization responsible for developing the data products. The Naval Research Laboratory was responsible for the ground processing system for the Clementine Spacecraft.

PRODUCT_TYPE = EDR

Image data products are identified as an EDR (Experimental Data Record). The images are unprocessed and contain all of the characteristics and artifacts of "raw" images as acquired by the spacecraft.

EDR_SOFTWARE_NAME = "NRL-ACT-MGRAB V1.2"

Version number of the software system that created the data products.

MISSION_PHASE_NAME = "xxxxxxxx"

Mission Phase names:
LOW EARTH ORBIT
LUNAR MAPPING
EARTH PHASING LOOP A
EARTH PHASING LOOP B

DATA_QUALITY_ID = "N/A"

Data Quality indicator. This keyword is reserved for future use. As processing of Clementine data proceeds, this keyword may be used to describe data quality information. No data quality parameters have currently been defined.

TARGET_NAME = "xxxxxx"

Observational target: MOON, EARTH, SKY

The TARGET body is determined by the PICGEO program algorithm:

1) For each possible target body (a target selection list is specified to the PICGEO program), it determines if the body is partly or entirely in the camera's field of view.

2) If only one body is in the field of view, that body is the target body.

3) If multiple bodies are in the field of view, and one or more bodies intersect the camera boresight, the closest one to the S/C is the target body.

4) If multiple bodies are in the field of view, and no bodies intersect the camera boresight, the closest one to the S/C is the target body.

5) If no bodies are in the camera's field of view, the target body is 'SKY'.

REVOLUTION_NUMBER = xxx

The revolution number refers to an observational pass over the moon. The revolution number is incremented by one each time the spacecraft passes over the south pole prior to the beginning of data acquisition. REVOLUTION_NUMBER is used in lieu of orbit number because of the way the orbit number was defined by the mission. The orbit number is incremented at the equator on the sun lit side of the Moon. Thus, the orbit number is changed in the middle of an observational pass. This proved to be awkward in defining the data acquired by a single pass over the Moon.

FRAME_SEQUENCE_NUMBER = xxxxxx

Sequential frame number of the image acquired during a pass over the Moon. For non-lunar mapping phase of mission the sequence number refers to the image sequence within a spacecraft memory download.

START_TIME = 1994-01-01T03:24:10.444Z

Time of start of observation. This time refers to the start of the integration time of the camera. The value contained in this keyword reflects a "corrected time". A software problem onboard the spacecraft caused inaccurate times to be attached to an image. This value contains the best estimated time of the observation.

STOP_TIME = "N/A"

This keyword is a required element for PDS data products and is included in the label for conformance to PDS standards.

UNCORRECTED_START_TIME = 1994-01-01T03:24:10.444Z

This keyword contains the time of the observation as sent down by the spacecraft. This time may be incorrect due to a software problem that existed onboard the spacecraft. The difference between the START_TIME and the UNCORRECTED_START_TIME is the estimated correction that was applied to the START_TIME.

SPACECRAFT_CLOCK_START_COUNT = "N/A"

Clock count of the spacecraft computer at the start of the image observation. The computer clock count was not available for the data products. This keyword is a required element for PDS data products and is included for conformance to the standard.

SPACECRAFT_CLOCK_STOP_COUNT = "N/A"

Clock count of the spacecraft computer at the end of the image observation. The computer clock count was not available for the data products. This keyword is a required element for PDS data products and is included for conformance to the standard.

PRODUCT_CREATION_TIME = 1994-02-26T21:17:06

Date and time for which the EDR product was created.

INSTRUMENT_NAME = "xxxxxxxx"

Name of camera:
NEAR INFRARED CAMERA
LIDAR HIGH-RESOLUTION IMAGER
ULTRAVIOLET/VISIBLE CAMERA
LONG WAVELENGTH INFRARED CAMERA
A STAR TRACKER CAMERA
B STAR TRACKER CAMERA

INSTRUMENT_ID = "xxxxxx"

A-STAR (A star tracker camera)
B-STAR (B star tracker camera)
HIRES (HiResolution camera)
UVVIS (Ultra Violet/Visible camera)
LWIR (Long wavelength infrared camera)
NIR (Near Infrared camera)

FILTER_NAME = "xx"

Filter name. The filter names are assigned alpha letters to designate the filter position. The CENTER_FILTER_WAVELENGTH parameter defines the central wavelength of the filter. Values for each camera are shown, center wavelength and bandwidth are given in nanometers.

Camera/Filter/Center/Bandwidth

UVVIS	**A** -	415	40	
	B -	750	10	
	C -	900	20	
	D -	950	30	
	E -	1000	30	
	F -	650	550	(BROADBAND FILTER)
NIR	**A** -	1100	60	
	B -	1250	60	
	C -	1500	60	
	D -	2000	60	
	E -	2600	60	
	F -	2780	60	
HIRES	**A** -	415	40	
	B -	560	50	
	C -	650	50	
	D -	750	50	
	E -	650	350	(BROADBAND FILTER)
	F -	N/A	N/A	(OPAQUE FILTER)
LWIR	**A** -	8750	1500	
A-STAR	**A** -	N/A	N/A	(BROADBAND, NO FILTER WHEEL)
B-STAR	**A** -	N/A	N/A	(BROADBAND, NO FILTER WHEEL)

CENTER_FILTER_WAVELENGTH = xxxx <nm>

The center_filter_wavelength element provides the mid point wavelength value between the minimum and maximum instrument filter wavelength values.

BANDWIDTH = xxxx <nm>

The bandwidth element provides a measure of the spectral width of a filter (nanometers). For a root-mean-square detector this is the effective bandwidth of the filter i.e., the full width of an ideal square filter having a flat response over the bandwidth and zero response elsewhere.

GAIN_MODE_ID = "xxx"

Gain mode of the Camera. Mode that defines the sensitivity of the detector.

MCP_GAIN_MODE_ID = "xxx"

Micro Channel Plate (MCP) gain mode. This keyword is applicable only to the HIRES camera.

OFFSET_MODE_ID = "xxx"

Mode specifies the analog value that is subtracted from the video signal prior to the Analog/digital converters.

EXPOSURE_DURATION = xxxx <ms>

Exposure duration (integration time) of the image observation expressed in milliseconds.

LENS_TEMPERATURE = xxx.xx <K>

Temperature of the camera lens in degrees Kelvin at the time the observation was made. This parameter is "N/A" for the HIRES camera because not temperature sensor was available at the lens.

FOCAL_PLANE_TEMPERATURE = xxx.xx <K>

Temperature of the focal plane array in degrees Kelvin at the time the observation was made.

CRYOCOOLER_TEMPERATURE = xxx.xx <K>

Temperature of the Cryocooler at time observation was made. This field applicable only to the NIR and LWIR cameras.

CRYOCOOLER_DURATION = xxxx <s>

Time that has transpired since the cryocooler was turned on. This field applicable only to the NIR and LWIR cameras.

RIGHT_ASCENSION = xxxx.xxx <deg>

The right ascension of the camera boresight. The values are specified relative to the J2000 inertial reference frame.

DECLINATION = xxxx.xxx <deg>

The declination of the camera boresight. The values are specified relative to the J2000 inertial reference frame.

TWIST_ANGLE = xxxx.xxx <deg>

The element TWIST_ANGLE provides the angle of rotation about optical axis relative to celestial coordinates. The right ascension, declination, and twist angles define the pointing direction of the scan platform.

RETICLE_POINT_RA = (xxxx.xx, xxxx.xx, xxxx.xx, xxxx.xx)
RETICLE_POINT_DECLINATION = (xxxx.xx, xxxx.xx, xxxx.xx, xxxx.xx)

These parameters refer to the right ascension and declination of the principle points of the camera. For the Clementine cameras the principle points are defined as the upper left pixel of the camera (line 1, sample 1), the upper right pixel (line 1 , last sample), lower left (last line, sample 1), and lower right(last line, last sample). The reticule point RA and DEC are expressed in degrees.

SEQUENCE_TABLE_ID = "xxx"

This parameter contains the image acquisition sequence code that specifies the camera/filter image sequencing for a set of observations. The ID indicates the order in which cameras are shuttered and the order for which filters are used in the set of observations. The sequence tables will be defined in the ancillary CD-ROM data products that accompany the Clementine EDR archive.

SC_TARGET_POSITION_VECTOR = (xxxxxxxx.xx, yyyyyyyyyy.yy, zzzzzzzz.zz)

x-, y-, and z- components of the position vector from observer to target center expressed in J2000 coordinates, and corrected for light time and stellar aberration, evaluated at epoch at which image was taken. Units are expressed in kilometers.

SC_TARGET_VELOCITY_VECTOR = (xxxxxxx.xx, yyyyyyyy.yy, zzzzzxxxz.zz)

x-, y-, and z- components of velocity vector of target relative to observer, expressed in J2000 coordinates, and corrected for light time, evaluated at epoch at which image was taken. Units are expressed in kilometers/second.

TARGET_CENTER_DISTANCE = xxxx.xxx <km>

The target_center_distance element provides the distance between the spacecraft and the center of the named target, expressed in kilometers.

SLANT_DISTANCE = xxxx.xxx <km>

Distance from spacecraft to camera boresight intercept point on surface expressed in kilometers.

CENTER_LATITUDE = xxxx.xxx <deg>
CENTER_LONGITUDE = xxxx.xxx <deg>

Planetocentric latitude and longitude of camera boresight intercept point.

HORIZONTAL_PIXEL_SCALE = xxxxx.xxxx <km>
VERTICAL_PIXEL_SCALE = xxxxx.xxxx <km>

Distance, measured along horizontal and vertical directions, along target surface between intercept points defined by centers of left and right edges of pixel-sized region in FOV centered at camera boresight. Defined only when boresight intercepts surface. Units are in kilometers.

SMEAR_MAGNITUDE = xxxx.xx <pixels>

Norm of velocity vector of camera boresight intercept point projected on target, multiplied by the exposure duration with the scale of the image factored to obtain the smear in pixels. Spacecraft rotation is taken into account. (Units are in pixels.)

SMEAR_AZIMUTH = xxxxx.xx <deg>

Azimuth of smear velocity vector. The reference line for the angle extends from the center of the image to the right edge of the image. The angle increases in the clock-wise direction. The angle is measured to the "image" of the smear velocity vector in the camera's focal plane. This image is computed by orthogonally projecting the smear vector onto the image plane and then applying whatever transformations are required to orient the result properly with respect to the image. The specific transformations to be performed are given by the camera's I-kernel.

NORTH_AZIMUTH = xxxxx.xxx <deg>
Analogs to smear azimuth, but applies to the target north pole direction vector.

RETICLE_POINT_LATITUDE = (xxxx.xx, xxxx.xx, xxxx.xx, xxxx.xx)
RETICLE_POINT_LONGITUDE = (xxxx.xx, xxxx.xx, xxxx.xx, xxxx.xx)
Latitudes and longitudes of the surface intercept points of the principle points of the camera. (see RETICLE_POINT_RA for definition of the reticule points for Clementine. The units are expressed in degrees.

SUB_SPACECRAFT_LATITUDE = xxxx.xxx <deg>
SUB_SPACECRAFT_LONGITUDE= xxxx.xxx <deg>
Planetocentric latitude and longitude of spacecraft-to-centerbody-center surface intercept vector. These parameters and the SPACECRAFT_ALTITUDE, SUB_SPACECRAFT_AZIMUTH parameters described below are relative to the central body for which the spacecraft is orbiting and not the target of the observation.

SPACECRAFT_ALTITUDE = xxxxxxx.xxx <km>
Altitude of spacecraft above reference ellipsoid. Distance is measured to closest point on ellipsoid.

SUB_SPACECRAFT_AZIMUTH = xxxxxxxx.xxx <deg>
Azimuth angle of sub-spacecraft point in image. Method of measurement is same as for smear azimuth (see above).

SPACECRAFT_SOLAR_DISTANCE = xxxxxxxx.xxxx <km>
Analogous to "target center distance," but Sun replaces target body in computation.

SC_SUN_POSITION_VECTOR = (xxxxxxx.xx, yyyyyy.yy, zzzzzzz.zz)
x-, y-, and z- components of position vector from observer to sun, center expressed in J2000 coordinates, and corrected for light time and stellar aberration, evaluated at epoch at which image was taken. Units are kilometers.

SC_SUN_VELOCITY_VECTOR = (xxxxxxxx.xx, yyyyyyy.yy, zzzzzzz.zz)
x-, y-, and z- components of velocity vector of sun relative to observer, expressed in J2000 coordinates, and corrected for light time, evaluated at epoch at which image was taken. Units are kilometers/second.

SOLAR_DISTANCE = xxxxxxxx.xx <km>
Distance from target body center to Sun. The Sun position used is that described above.

SUB_SOLAR_AZIMUTH = xxxxx.xx <deg>
Azimuth of the apparent sub-solar point, as seen by the spacecraft. This point is the surface intercept of the target-center-to-Sun vector, evaluated at the camera epoch minus one-way light time from target to spacecraft at that epoch spacecraft at that epoch. Azimuth is measured as described above. Target body position

relative to the spacecraft is corrected for light-time and stellar aberration. Target body orientation is corrected for light-time.

SUB_SOLAR_LATITUDE = xxxx.xx <deg>
SUB_SOLAR_LONGITUDE = xxxx.xx <deg>

Planetocentric latitude and longitude of the apparent sub-solar point.

INCIDENCE_ANGLE = xxxx.xx <deg>
PHASE_ANGLE = xxxx.xx <deg>
EMISSION_ANGLE = xxxx.xx <deg>

These angles are measured at the camera boresight intercept point. The target-Sun vector is the same as that used in the sub-solar point computation. The spacecraft-target vector is the same as that used in the camera boresight intercept computation.
The INCIDENCE ANGLE is the angle between the target-Sun vector and the local vertical vector at the boresight intercept.
The PHASE ANGLE is measured between the boresight intercept-to-Sun vector and the negative of the boresight vector.
The EMISSION ANGLE is measured between the negative of the boresight vector and the local vertical vector at the boresight intercept.

LOCAL_HOUR_ANGLE = xxxx.xx <deg>

The angle from the negative of the target-body-to-Sun vector to the projection of the negative of the spacecraft-to-target vector onto the target's instantaneous orbital plane. Both vectors are computed as in the sub-spacecraft point computation. The angle is measured in a counterclockwise direction when viewed from North of the ecliptic plane.

LIGHT_SOURCE_NAME = "xxxxx"

Name of secondary light source.
EARTH when making lunar observations
MOON when making earth observations

LIGHT_SOURCE_DISTANCE = xxxxxx.xxx <km>

Distance from target body center and secondary light source center.

SUB_LIGHT_SOURCE_AZIMUTH = xxxx.xx <deg>

Analogs to sub solar azimuth but using secondary light source instead of sun.

SUB_LIGHT_SOURCE_LATITUDE = xxxx.xx <deg>
SUB_LIGHT_SOURCE_LONGITUDE = xxxx.xx <deg>

Analogs to sub solar latitude and longitude but using secondary light source instead of sun.

LIGHT_SOURCE_INCIDENCE_ANGLE = xxxx.xx <deg>
LIGHT_SOURCE_PHASE_ANGLE = xxxx.xx <deg>

Analogs to incidence and phase angles but using secondary light source instead of sun.

OBJECT = IMAGE_HISTOGRAM
ITEMS = 256
DATA_TYPE = LSB_INTEGER
ITEM_BYTES = 8
END_OBJECT

These keywords describe the histogram object.

```
OBJECT = BROWSE_IMAGE
 LINES          = xxxx
 LINE_SAMPLES   = xxxx
 SAMPLING_FACTOR = 8
 SAMPLE_TYPE    = UNSIGNED_INTEGER
 SAMPLE_BITS    = 8
END_OBJECT
```

These keywords describe the browse image object. The browse image is an uncompressed subsampled version of the image. SAMPLING_FACTOR refers to the subsampling of every N-th pixel in the line and sample direction. The pixel values in the NxN array are averaged before subsampling.

```
OBJECT = IMAGE
 ENCODING_TYPE = "CLEM-JPEG-0"
 ENCODING_COMPRESSION_RATIO = xxxx.xx
 LINES          = xxxx
 LINE_SAMPLES   = xxxx
 SAMPLE_TYPE    = UNSIGNED_INTEGER
 SAMPLE_BITS    = 8
 MAXIMUM        = xxx
 MINIMUM        = xxx
 MEAN           = xxx
 STANDARD_DEVIATION = xxxx.xxx
 CHECKSUM = xxxxxxxx
END_OBJECT
END
```

These keywords describe the image object. Data are in a compressed form, the huffman table, and DCT coefficients are stored in the object. Access to this object is through the decompression software. MINIMUM, MAXIMUM, MEAN, and STANDARD_DEVIATION refers to the DN values of the image array. The CHECKSUM parameter refers to the sum of the bytes in the object in compressed form. The ENCODING_COMPRESSION_RATIO specifies the compression factor of the data. There are three permitted values for the ENCODING_TYPE: "N/A" indicates the image was not compressed on the spacecraft and so the data are not in a compressed format. "CLEM-JPEG-0" and "CLEM-JPEG-1" indicates the data were compressed onboard the spacecraft and the data are stored in a compressed form. See Appendix II for a description of the two data decompression forms.

APPENDIX I - SPICE Kernel Files Used In Clementine Data Products

The following SPICE kernel files were inputs to the Picture Geometry program (PICGEO) used to compute the geometric quantities found in the PDS image labels and the Image Index files (IMGINDX.TAB) archived in this volume set. Improvements to some of these fundamental ancillary data will be made as further analysis of Clementine data continues, so the geometric quantities found in the labels should not be used for precision science data analyses.

clemdef.bsp:
Clementine spacecraft trajectory file. The ephemeris in this file was produced by the Naval Research Laboratory, based on orbit solutions provided by the Goddard Space Flight Center Flight Dynamics Facility. The NRL data, given in the SERF form, were converted to the SPICE SPK format using the serf2spk utility provided by NAIF.

de245.bsp:
JPL planetary and lunar ephemeris file, in SPICE SPK format.

clemdef.bck:
Clementine spacecraft orientation file. The pointing in this file is discrete, stored every 5 seconds during periods of imaging and every 60 seconds during periods of non-imaging. There are gaps in coverage. The pointing data in this file were NOT corrected for known discrepancies between A- and B- star tracker alignment. The data are in SPICE CK format.

dspse002.tsc:
Clementine spacecraft clock coefficients file, in SPICE SCLK format.

pck00003.tpc:
Planetary constants kernel file, in the SPICE text-PcK format. This was used for modeling the size, shape and orientation of the earth, and the size and shape (not orientation) of the moon.

de245l.bpc:
Lunar orientation model using numerically integrated physical librations. This model uses the mean earth axes, not the principal axes used in the IAU publications from which the pck00003.tpc data were obtained. The difference between these two models is thought to be several hundred meters.

naif0003.tls:
NAIF leapseconds kernel file, used for converting between Universal Time Coordinated (UTC) and Barycentric Dynamical Time (TDB, also called Ephemeris Time, or ET).

The seven instrument kernel files below contain the instrument mounting alignment relative to the spacecraft, and the following instrument geometric parameters: focal length, focal plane dimension, pixel size, and the coefficient of radially symmetric optical distortion. ASTAR and BSTAR are the A- and B- star trackers that provided spacecraft attitude reference as well as scientific images.

hires005.ti: HIRES instrument kernel file.

uvvis005.ti: UVVIS instrument kernel file.

lwir005.ti: LWIR instrument kernel file.

nir005.ti: NIR instrument kernel file.

lidar002.ti: LIDAR instrument kernel file.

astar004.ti: ASTAR instrument kernel file.

bstar004.ti: BSTAR instrument kernel file.

APPENDIX II - Data Compression Coefficients

The Clementine Data Handling Unit (DHU) permits 4 data compression parameter sets to be loaded at any given time, i.e. Sets 0-3. These data compression parameter sets are used to drive the MATRA compression chip. This chip permits the real time compression of images using a compression scheme that is similar to the JPEG standard but not identical.

Each data compression parameter set is composed of:

- TabQ table - which contains 64 values
- Huffman Table - which contains the huffman encoding constants,
- TabF vector - which contains a vector with 16 possible scaling constants to use.

During the Clementine mission:

<> Set 0 corresponded to MATRA's default data compression parameter set. The ENCODING_TYPE = "CLEM-JPEG-0" signifies Set 0 parameters were used in the compression.

<> Set 1 corresponded to a flat quantization table for all frequencies. This is the set that was primarily used during the whole mission. The ENCODING_TYPE = "CLEM-JPEG-1" signifies Set 1 parameters were used in the compression.

<> Sets 2-3 were identical to Set 1. If needed they were going to be modified during flight. After a number of quick studies, using data from the first few orbits around the Moon, it was decided that this was not needed.

BASIC DIFFERENCE BETWEEN STANDARD JPEG AND THE MATRA IMPLEMENTATION

<u>Standard JPEG Frequency Quantization Scheme</u>

In the standard JPEG algorithm the frequency coefficients X(u,v) [*using here a notation similar to the one used in the English version of the MATRA chip manual*] are transformed by the following equation before the frequency coefficients are Huffman encoded:

$$Xq(u,v) = \mathrm{int9bit}[X(u,v)/q(u,v)] \quad (1)$$

where,

- X(u,v) is a 12 bit signed number representing the DCT coefficient at the frequency indices (u,v).
- q(u,v) quantization table coefficient at the frequency index (u,v), this is an 8 bit positive number (1-255).

In the decompression stage the value of X(u,v) is reconstructed from the following equation:

$$Xr(u,v) = \mathrm{int9bit}[X(u,v)/q(u,v)].q(u,v)$$

Equation (1) is a lossy operation due to the integer truncation.

For the set of lunar test images we have been working with a small value of q(u,v), say q(u,v)=1, results in compression ratios close to the original CLEMENTINE baseline requirement of 4 to 1. Hence we were particular interested in looking at what is the smaller value of q'(u,v) that can be represented by the MATRA chip hardware.

MATRA's Implementations of the JPEG Frequency Quantization Scheme

In the MATRA chip the desired quantization coefficient factor, q(u,v), is approximated in hardware using an effective q'(u,v), i.e.

```
 Xq'(u,v) = int9bit[X(u,v)/q'(u,v)]
          = int9bit[int8bit[ ((TABF*TABQ(u,v))/64))/4094)).X(u,v)] (2)
```

where:

```
   TABF       is an 8 bit positive quantity used for scaling purposes,
   TABQ (u,v) is a derived 8 bit positive number defined by

   TABQ=int8bit[255*10/q(u,v)]
```

In other words, in the MATRA chip a desired JPEG quantization coefficient value, q(u,v), is implemented as an effective q'(u,v) value of:

```
    q'(u,v)= 4094/(int8bit[TABF.TABQ/64])
           = 4094/(int8bit[(TABF/64).int8bit[(255*10)/q(u,v)])
             >= 4
```

Notice that since TABF and TABQ are 8 bit positive numbers it follows that 4 <= q'(u,v).

Hence, the minimum effective quantization table coefficient value achievable in the MATRA chip is four.

The following Table summarizes the data compression parameter sets loaded to the Clementine Spacecraft during Mission Operations. Note that only set 0 and 1 are distinct.

TabF	**Set0**	**Set1**	**Set2**	**Set3**
TABF(00)	FFh	FFh	FFh	FFh
TABF(01)	FFh	FFh	FFh	FFh
TABF(02)	FFh	FFh	FFh	FFh
TABF(03)	FFh	FFh	FFh	FFh
TABF(04)	BDh	BDh	BDh	BDh
TABF(05)	8dh	8dh	8dh	8dh
TABF(06)	6Fh	6Fh	6Fh	6Fh
TABF(07)	59h	59h	59h	59h
TABF(08)	4Bh	4Bh	4Bh	4Bh
TABF(09)	3fh	3fh	3fh	3fh
TABF(10)	37h	37h	37h	37h
TABF(11)	30h	30h	30h	30h
TABF(12)	2Bh	2Bh	2Bh	2Bh
TABF(13)	2bh	2bh	2bh	2bh
TABF(14)	26h	26h	26h	26h

TABF(15) 23h 23h 23h 23h

TabQ Value

Q	Set0	S1	S2	S3
Q(0,0)	9Fh	FF	FF	FF
Q(0,1)	D4h	FF	FF	FF
Q(0,2)	B6h	FF	FF	FF
Q(0,3)	B6h	FF	FF	FF
Q(0,4)	8Eh	FF	FF	FF
Q(0,5)	6Ah	FF	FF	FF
Q(0,6)	34h	FF	FF	FF
Q(0,7)	23h	FF	FF	FF
Q(1,0)	E8h	FF	FF	FF
Q(1,1)	D4h	FF	FF	FF
Q(1,2)	C4h	FF	FF	FF
Q(1,3)	96h	FF	FF	FF
Q(1,4)	74h	FF	FF	FF
Q(1,5)	49h	FF	FF	FF
Q(1,6)	28h	FF	FF	FF
Q(1,7)	1Ch	FF	FF	FF
Q(2,0)	FFh	FF	FF	FF
Q(2,1)	B6h	FF	FF	FF
Q(2,2)	9Fh	FF	FF	FF
Q(2,3)	74h	FF	FF	FF
Q(2,4)	45h	FF	FF	FF
Q(2,5)	2Eh	FF	FF	FF
Q(2,6)	21h	FF	FF	FF
Q(2,7)	1Bh	FF	FF	FF
Q(3,0)	9Fh	FF	FF	FF
Q(3,1)	86h	FF	FF	FF
Q(3,2)	6Ah	FF	FF	FF
Q(3,3)	58h	FF	FF	FF
Q(3,4)	2Eh	FF	FF	FF
Q(3,5)	28h	FF	FF	FF
Q(3,6)	1Dh	FF	FF	FF
Q(3,7)	1Ah	FF	FF	FF
Q(4,0)	6Ah	FF	FF	FF
Q(4,1)	62h	FF	FF	FF
Q(4,2)	40h	FF	FF	FF
Q(4,3)	32h	FF	FF	FF
Q(4,4)	26h	FF	FF	FF
Q(4,5)	1Fh	FF	FF	FF
Q(4,6)	19h	FF	FF	FF
Q(4,7)	17h	FF	FF	FF
Q(5,0)	40h	FF	FF	FF
Q(5,1)	2Ch	FF	FF	FF
Q(5,2)	2Dh	FF	FF	FF
Q(5,3)	1Dh	FF	FF	FF
Q(5,4)	17h	FF	FF	FF
Q(5,5)	19h	FF	FF	FF
Q(5,6)	15h	FF	FF	FF
Q(5,7)	1Ah	FF	FF	FF
Q(6,0)	32h	FF	FF	FF
Q(6,1)	2Ah	FF	FF	FF
Q(6,2)	25h	FF	FF	FF
Q(6,3)	20h	FF	FF	FF
Q(6,4)	19h	FF	FF	FF
Q(6,5)	17h	FF	FF	FF
Q(6,6)	15h	FF	FF	FF
Q(6,7)	19h	FF	FF	FF

Q(7,0)	2Ah	FF	FF	FF
Q(7,1)	2Eh	FF	FF	FF
Q(7,2)	2Eh	FF	FF	FF
Q(7,3)	29h	FF	FF	FF
Q(7,4)	21h	FF	FF	FF
Q(7,5)	1Ch	FF	FF	FF
Q(7,6)	19h	FF	FF	FF
Q(7,7)	1Ah	FF	FF	FF

Huf Tab	**Set0**	**Set1**	**Set2**	**Set3**
VLC(00)	04h	04h	04h	04h
VLC(01)	05h	05h	05h	05h
VLC(02)	00h	00h	00h	00h
VLC(03)	00h	00h	00h	00h
VLC(04)	00h	00h	00h	00h
VLC(05)	00h	00h	00h	00h
VLC(06)	00h	00h	00h	00h
VLC(07)	00h	00h	00h	00h
VLC(08)	00h	00h	00h	00h
VLC(09)	00h	00h	00h	00h
VLC(10)	00h	00h	00h	00h
VLC(11)	00h	00h	00h	00h
VLC(12)	00h	00h	00h	00h
VLC(13)	00h	00h	00h	00h
VLC(14)	00h	00h	00h	00h
VLC(15)	00h	00h	00h	00h
VLC(16)	00h	00h	00h	00h
VLC(17)	00h	00h	00h	00h
VLC(18)	00h	00h	00h	00h
VLC(19)	00h	00h	00h	00h
VLC(20)	00h	00h	00h	00h
VLC(21)	00h	00h	00h	00h
VLC(22)	00h	00h	00h	00h
VLC(23)	00h	00h	00h	00h
VLC(24)	00h	00h	00h	00h
VLC(25)	00h	00h	00h	00h
VLC(26)	00h	00h	00h	00h
VLC(27)	00h	00h	00h	00h
VLC(28)	00h	00h	00h	00h
VLC(29)	00h	00h	00h	00h
VLC(30)	10h	10h	10h	10h
VLC(31)	2Fh	2Fh	2Fh	2Fh
VLC(32)	02h	02h	02h	02h
VLC(33)	00h	00h	00h	00h
VLC(34)	04h	04h	04h	04h
VLC(35)	03h	03h	03h	03h
VLC(36)	05h	05h	05h	05h
VLC(37)	1Bh	1Bh	1Bh	1Bh
VLC(38)	06h	06h	06h	06h
VLC(39)	17h	17h	17h	17h
VLC(40)	06h	06h	06h	06h
VLC(41)	37h	37h	37h	37h
VLC(42)	07h	07h	07h	07h
VLC(43)	2Fh	2Fh	2Fh	2Fh
VLC(44)	07h	07h	07h	07h
VLC(45)	6Fh	6Fh	6Fh	6Fh
VLC(46)	08h	08h	08h	08h
VLC(47)	9Fh	9Fh	9Fh	9Fh
VLC(48)	08h	08h	08h	08h

VLC(49)	5Fh	5Fh	5Fh	5Fh
VLC(50)	09h	09h	09h	09h
VLC(51)	1Fh	1Fh	1Fh	1Fh
VLC(52)	09h	09h	09h	09h
VLC(53)	9Fh	9Fh	9Fh	9Fh
VLC(54)	09h	09h	09h	09h
VLC(55)	5Fh	5Fh	5Fh	5Fh
VLC(56)	0Ah	0Ah	0Ah	0Ah
VLC(57)	5Fh	5Fh	5Fh	5Fh
VLC(58)	0Bh	0Bh	0Bh	0Bh
VLC(59)	5Fh	5Fh	5Fh	5Fh
VLC(60)	0Fh	0Fh	0Fh	0Fh
VLC(61)	03h	03h	03h	03h
VLC(62)	10h	10h	10h	10h
VLC(63)	AFh	AFh	AFh	AFh
VLC(64)	02h	02h	02h	02h
VLC(65)	02h	02h	02h	02h
VLC(66)	06h	06h	06h	06h
VLC(67)	27h	27h	27h	27h
VLC(68)	08h	08h	08h	08h
VLC(69)	1Fh	1Fh	1Fh	1Fh
VLC(70)	09h	09h	09h	09h
VLC(71)	EFh	EFh	EFh	EFh
VLC(72)	0Ah	0Ah	0Ah	0Ah
VLC(73)	1Fh	1Fh	1Fh	1Fh
VLC(74)	0Ah	0Ah	0Ah	0Ah
VLC(75)	9Fh	9Fh	9Fh	9Fh
VLC(76)	0Bh	0Bh	0Bh	0Bh
VLC(77)	1Fh	1Fh	1Fh	1Fh
VLC(78)	0Bh	0Bh	0Bh	0Bh
VLC(79)	9Fh	9Fh	9Fh	9Fh
VLC(80)	0Ch	0Ch	0Ch	0Ch
VLC(81)	EFh	EFh	EFh	EFh
VLC(82)	10h	10h	10h	10h
VLC(83)	7Dh	7Dh	7Dh	7Dh
VLC(84)	10h	10h	10h	10h
VLC(85)	E3h	E3h	E3h	E3h
VLC(86)	10h	10h	10h	10h
VLC(87)	0Bh	0Bh	0Bh	0Bh
VLC(88)	10h	10h	10h	10h
VLC(89)	9Bh	9Bh	9Bh	9Bh
VLC(90)	10h	10h	10h	10h
VLC(91)	47h	47h	47h	47h
VLC(92)	10h	10h	10h	10h
VLC(93)	D7h	D7h	D7h	D7h
VLC(94)	10h	10h	10h	10h
VLC(95)	6Fh	6Fh	6Fh	6Fh
VLC(96)	03h	03h	03h	03h
VLC(97)	01h	01h	01h	01h
VLC(98)	07h	07h	07h	07h
VLC(99)	4Fh	4Fh	4Fh	4Fh
VLC(100)	0Ah	0Ah	0Ah	0Ah
VLC(101)	EFh	EFh	EFh	EFh
VLC(102)	0Bh	0Bh	0Bh	0Bh
VLC(103)	EFh	EFh	EFh	EFh
VLC(104)	10h	10h	10h	10h
VLC(105)	69h	69h	69h	69h
VLC(106)	10h	10h	10h	10h
VLC(107)	79h	79h	79h	79h
VLC(108)	10h	10h	10h	10h

VLC(109)	65h	65h	65h	65h
VLC(110)	10h	10h	10h	10h
VLC(111)	75h	75h	75h	75h
VLC(112)	10h	10h	10h	10h
VLC(113)	6Dh	6Dh	6Dh	6Dh
VLC(114)	10h	10h	10h	10h
VLC(115)	FDh	FDh	FDh	FDh
VLC(116)	10h	10h	10h	10h
VLC(117)	13h	13h	13h	13h
VLC(118)	10h	10h	10h	10h
VLC(119)	8Bh	8Bh	8Bh	8Bh
VLC(120)	10h	10h	10h	10h
VLC(121)	5Bh	5Bh	5Bh	5Bh
VLC(122)	10h	10h	10h	10h
VLC(123)	C7h	C7h	C7h	C7h
VLC(124)	10h	10h	10h	10h
VLC(125)	37h	37h	37h	37h
VLC(126)	10h	10h	10h	10h
VLC(127)	EFh	EFh	EFh	EFh
VLC(128)	04h	04h	04h	04h
VLC(129)	0Dh	0Dh	0Dh	0Dh
VLC(130)	09h	09h	09h	09h
VLC(131)	6Fh	6Fh	6Fh	6Fh
VLC(132)	0Ch	0Ch	0Ch	0Ch
VLC(133)	6Fh	6Fh	6Fh	6Fh
VLC(134)	10h	10h	10h	10h
VLC(135)	F1h	F1h	F1h	F1h
VLC(136)	10h	10h	10h	10h
VLC(137)	E9h	E9h	E9h	E9h
VLC(138)	10h	10h	10h	10h
VLC(139)	F9h	F9h	F9h	F9h
VLC(140)	10h	10h	10h	10h
VLC(141)	E5h	E5h	E5h	E5h
VLC(142)	10h	10h	10h	10h
VLC(143)	F5h	F5h	F5h	F5h
VLC(144)	10h	10h	10h	10h
VLC(145)	EDh	EDh	EDh	EDh
VLC(146)	10h	10h	10h	10h
VLC(147)	03h	03h	03h	03h
VLC(148)	10h	10h	10h	10h
VLC(149)	93h	93h	93h	93h
VLC(150)	10h	10h	10h	10h
VLC(151)	4Bh	4Bh	4Bh	4Bh
VLC(152)	10h	10h	10h	10h
VLC(153)	DBh	DBh	DBh	DBh
VLC(154)	10h	10h	10h	10h
VLC(155)	27h	27h	27h	27h
VLC(156)	10h	10h	10h	10h
VLC(157)	B7h	B7h	B7h	B7h
VLC(158)	10h	10h	10h	10h
VLC(159)	1Fh	1Fh	1Fh	1Fh
VLC(160)	05h	05h	05h	05h
VLC(161)	0Bh	0Bh	0Bh	0Bh
VLC(162)	0Bh	0Bh	0Bh	0Bh
VLC(163)	6Fh	6Fh	6Fh	6Fh
VLC(164)	10h	10h	10h	10h
VLC(165)	91h	91h	91h	91h
VLC(166)	10h	10h	10h	10h
VLC(167)	09h	09h	09h	09h
VLC(168)	10h	10h	10h	10h

VLC(169)	19h	19h	19h	19h
VLC(170)	10h	10h	10h	10h
VLC(171)	05h	05h	05h	05h
VLC(172)	10h	10h	10h	10h
VLC(173)	15h	15h	15h	15h
VLC(174)	10h	10h	10h	10h
VLC(175)	0Dh	0Dh	0Dh	0Dh
VLC(176)	10h	10h	10h	10h
VLC(177)	1Dh	1Dh	1Dh	1Dh
VLC(178)	10h	10h	10h	10h
VLC(179)	83h	83h	83h	83h
VLC(180)	10h	10h	10h	10h
VLC(181)	53h	53h	53h	53h
VLC(182)	10h	10h	10h	10h
VLC(183)	CBh	CBh	CBh	CBh
VLC(184)	10h	10h	10h	10h
VLC(185)	3Bh	3Bh	3Bh	3Bh
VLC(186)	10h	10h	10h	10h
VLC(187)	A7h	A7h	A7h	A7h
VLC(188)	10h	10h	10h	10h
VLC(189)	77h	77h	77h	77h
VLC(190)	10h	10h	10h	10h
VLC(191)	9Fh	9Fh	9Fh	9Fh
VLC(192)	06h	06h	06h	06h
VLC(193)	07h	07h	07h	07h
VLC(194)	10h	10h	10h	10h
VLC(195)	21h	21h	21h	21h
VLC(196)	10h	10h	10h	10h
VLC(197)	51h	51h	51h	51h
VLC(198)	10h	10h	10h	10h
VLC(199)	89h	89h	89h	89h
VLC(200)	10h	10h	10h	10h
VLC(201)	99h	99h	99h	99h
VLC(202)	10h	10h	10h	10h
VLC(203)	85h	85h	85h	85h
VLC(204)	10h	10h	10h	10h
VLC(205)	95h	95h	95h	95h
VLC(206)	10h	10h	10h	10h
VLC(207)	8Dh	8Dh	8Dh	8Dh
VLC(208)	10h	10h	10h	10h
VLC(209)	9Dh	9Dh	9Dh	9Dh
VLC(210)	10h	10h	10h	10h
VLC(211)	43h	43h	43h	43h
VLC(212)	10h	10h	10h	10h
VLC(213)	D3h	D3h	D3h	D3h
VLC(214)	10h	10h	10h	10h
VLC(215)	2Bh	2Bh	2Bh	2Bh
VLC(216)	10h	10h	10h	10h
VLC(217)	BBh	BBh	BBh	BBh
VLC(218)	10h	10h	10h	10h
VLC(219)	67h	67h	67h	67h
VLC(220)	10h	10h	10h	10h
VLC(221)	F7h	F7h	F7h	F7h
VLC(222)	10h	10h	10h	10h
VLC(223)	5Fh	5Fh	5Fh	5Fh
VLC(224)	07h	07h	07h	07h
VLC(225)	0Fh	0Fh	0Fh	0Fh
VLC(226)	10h	10h	10h	10h
VLC(227)	A1h	A1h	A1h	A1h
VLC(228)	10h	10h	10h	10h

VLC(229)	D1h	D1h	D1h	D1h
VLC(230)	10h	10h	10h	10h
VLC(231)	49h	49h	49h	49h
VLC(232)	10h	10h	10h	10h
VLC(233)	59h	59h	59h	59h
VLC(234)	10h	10h	10h	10h
VLC(235)	45h	45h	45h	45h
VLC(236)	10h	10h	10h	10h
VLC(237)	55h	55h	55h	55h
VLC(238)	10h	10h	10h	10h
VLC(239)	4Dh	4Dh	4Dh	4Dh
VLC(240)	10h	10h	10h	10h
VLC(241)	5Dh	5Dh	5Dh	5Dh
VLC(242)	10h	10h	10h	10h
VLC(243)	C3h	C3h	C3h	C3h
VLC(244)	10h	10h	10h	10h
VLC(245)	33h	33h	33h	33h
VLC(246)	10h	10h	10h	10h
VLC(247)	ABh	ABh	ABh	ABh
VLC(248)	10h	10h	10h	10h
VLC(249)	7Bh	7Bh	7Bh	7Bh
VLC(250)	10h	10h	10h	10h
VLC(251)	E7h	E7h	E7h	E7h
VLC(252)	10h	10h	10h	10h
VLC(253)	0Fh	0Fh	0Fh	0Fh
VLC(254)	10h	10h	10h	10h
VLC(255)	DFh	DFh	DFh	DFh
VLC(256)	0Ah	0Ah	0Ah	0Ah
VLC(257)	6Fh	6Fh	6Fh	6Fh
VLC(258)	10h	10h	10h	10h
VLC(259)	61h	61h	61h	61h
VLC(260)	10h	10h	10h	10h
VLC(261)	31h	31h	31h	31h
VLC(262)	10h	10h	10h	10h
VLC(263)	C9h	C9h	C9h	C9h
VLC(264)	10h	10h	10h	10h
VLC(265)	D9h	D9h	D9h	D9h
VLC(266)	10h	10h	10h	10h
VLC(267)	C5h	C5h	C5h	C5h
VLC(268)	10h	10h	10h	10h
VLC(269)	D5h	D5h	D5h	D5h
VLC(270)	10h	10h	10h	10h
VLC(271)	CDh	CDh	CDh	CDh
VLC(272)	10h	10h	10h	10h
VLC(273)	DDh	DDh	DDh	DDh
VLC(274)	10h	10h	10h	10h
VLC(275)	23h	23h	23h	23h
VLC(276)	10h	10h	10h	10h
VLC(277)	B3h	B3h	B3h	B3h
VLC(278)	10h	10h	10h	10h
VLC(279)	6Bh	6Bh	6Bh	6Bh
VLC(280)	10h	10h	10h	10h
VLC(281)	FBh	FBh	FBh	FBh
VLC(282)	10h	10h	10h	10h
VLC(283)	17h	17h	17h	17h
VLC(284)	10h	10h	10h	10h
VLC(285)	8Fh	8Fh	8Fh	8Fh
VLC(286)	10h	10h	10h	10h
VLC(287)	3Fh	3Fh	3Fh	3Fh
VLC(288)	03h	03h	03h	03h

VLC(289)	02h	02h	02h	02h
VLC(290)	03h	03h	03h	03h
VLC(291)	06h	06h	06h	06h
VLC(292)	03h	03h	03h	03h
VLC(293)	01h	01h	01h	01h
VLC(294)	02h	02h	02h	02h
VLC(295)	00h	00h	00h	00h
VLC(296)	03h	03h	03h	03h
VLC(297)	05h	05h	05h	05h
VLC(298)	03h	03h	03h	03h
VLC(299)	03h	03h	03h	03h
VLC(300)	04h	04h	04h	04h
VLC(301)	07h	07h	07h	07h
VLC(302)	05h	05h	05h	05h
VLC(303)	0Fh	0Fh	0Fh	0Fh
VLC(304)	06h	06h	06h	06h
VLC(305)	1Fh	1Fh	1Fh	1Fh
VLC(306)	07h	07h	07h	07h
VLC(307)	3Fh	3Fh	3Fh	3Fh
VLC(308)	00h	00h	00h	00h
VLC(309)	00h	00h	00h	00h
VLC(310)	00h	00h	00h	00h
VLC(311)	00h	00h	00h	00h
VLC(312)	00h	00h	00h	00h
VLC(313)	00h	00h	00h	00h
VLC(314)	00h	00h	00h	00h
VLC(315)	00h	00h	00h	00h
VLC(316)	00h	00h	00h	00h
VLC(317)	00h	00h	00h	00h
VLC(318)	00h	00h	00h	00h
VLC(319)	00h	00h	00h	00h