Chapter 7. Date/Time Format

PDS has adopted a subset of the International Standards Organization Standard (ISO/DIS) 8601 standard entitled "Data Element and Interchange Formats - Representations of Dates and Times", and applies the standard across all disciplines in order to give the system generality. See also Dates and Times in *Object Description Language* (Chapter 12, Section 12.3.2) of this document.

It is important to note that the ISO/DIS 8601 standard covers only ASCII representations of dates and times.

ODL Date/Time Information

Chapter 12, *Object Description Language (ODL) Specification and Usage*, Section 12.3.2, **Dates and Times**, of this document provides additional information on the use of ODL in date/time formation, representation, and implementation.

7.1 Date/Times

In the PDS there are two recognized date/time formats:

CCYY-MM-DDTHH:MM:SS.sss (preferred format)
CCYY-DDDTHH:MM:SS.sss

Each format represents a concatenation of the conventional date and time expressions with the two parts separated by the letter T:

CC	-	century (00-99)
YY	-	year (00-99)
MM	-	month (01-12)
DD	-	day of month (01-31)
DDD	-	day of year (001-366)
T	-	date/time separator
HH	-	hour (00-23)
MM	-	minute (00-59)
SS	-	second (00-59)
sss	-	fractions of second (000-999)

Note: See Section 7.4 "Midnight and Leap Seconds" for special cases involving the indication of midnight and leap seconds.

The preferred date/time format, is: CCYY-MM-DDTHH:MM:SS.sss

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PDS standard date/time format, i.e., t

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Date/Time Precision

The above date/time formats may be truncated on the right to match the precision of the date/time value in any of the following forms:

1998
1998-12
1998-12-01
1998-12-01T23
1998-12-01T23:59
1998-12-01T23:59:58
1998-12-01T23:59:58.1
1998-12-01T23:59:58.12

7.2 Dates

Dates should be expressed in the conventional ISO/DIS 8601 format. On those rare occasions when dates cannot be expressed in the conventional format, a native format may be used.

7.2.1 Conventional Dates

Conventional dates are represented in ISO/DIS 8601 format as either year (including century), month, day-of-month (CCYY-MM-DD), or as year, day-of-year (CCYY-DDD). The hyphen character ('-') is used as the field separator in this format. The year, month, day-of-month format is the preferred format for use in PDS labels and catalog files and is referred to as *PDS standard date format*, but either format is acceptable.

7.2.2 Native Dates

Dates in any format other than the ISO/DIS 8601 format described above are considered to be in a format native to the specific data set, thus "native dates". Native date formats are specified by the data preparer in conjunction with the PDS data engineer. Mission-elapsed days and time-to-encounter are both examples of native dates.

7.3 Times

The PDS allows times to be expressed in conventional and native (alternate) formats.

7.3.1 Conventional Times

Conventional times are represented as hours, minutes and seconds according to the ISO/DIS 8601 time format standard: HH:MM:SS[.sss]. Note that the hours, minutes, and integral seconds fields must contain two digits. The colon (':') is used as a field separator. Fractional seconds consisting of a decimal point (the European-style comma may not be used) and up to three digits (thousandths of a second) may be included if appropriate.

Coordinated Universal Time (UTC) is the PDS time standard and must be formatted in the

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ODL Date/Time Information¶
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previously described ISO/DIS 8601 standard format. The letter "Z", indicating the civil time zone at Greenwich (i.e., GMT), should never be appended to a UTC time. The relationship between UTC and GMT has varied historically and with observer context. Note that in PDS data sets created under earlier versions of the Standards, an appended "Z" is taken as indicating UTC.

The START_TIME and STOP_TIME data elements required in data product labels and catalog files are in UTC. For data collected by spacecraft-mounted instruments, the date/ time must be a time that corresponds to "spacecraft event time". For data collected by instruments not located on a spacecraft, this time shall be an earth-based event time.

Adoption of UTC (rather than spacecraft-clock-count, for example) as the standard facilitates comparison of data from a particular spacecraft or ground-based facility with data from other sources.

7.3.2 Native Times

Times in any format other than the ISO/DIS 8601 format described above are considered to be in a format native to the data set, and thus "native times". The NATIVE_START_TIME and NATIVE_STOP_TIME elements hold the native time equivalents of the UTC values in START_TIME and STOP_TIME, respectively.

There is one native time of particular interest, however, which has specific keywords associated with it. The spacecraft clock reading (that is, the "count") often provides the essential timing information for a space-based observation. Therefore, the elements SPACECRAFT_CLOCK_START_COUNT and SPACECRAFT_CLOCK_STOP_COUNT are required in labels describing space-based data. This value is formatted as a string to preserve precision.

Note that in rare cases in which there is more than one native time relevant to an observation, the data preparer should consult a PDS data engineer for assistance in selecting the appropriate PDS elements.

Examples of quantities that may be expressed in native time formats include:

1. Spacecraft Clock Count (sclk)
2. Ephemeris Time
3. Relative Time
4. Local Time

7.4 Midnight and Leap Seconds

The ISO/DIS 8601 standard for representation of midnight and leap seconds are also used in PDS time fields.

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¶
1. **Spacecraft Clock Count (sclk)** - Spacecraft clock count (sclk) provides a more precise time representation than event time for instrument-generated data sets, and so may be desirable as an additional time field. In a typical instance, a range of spacecraft-clock-count values (i.e., a start-and a stop-value) may be required.¶
¶
Spacecraft clock count (SPACECRAFT_CLOCK_START_COUNT and SPACECRAFT_CLOCK_STOP_COUNT) shall be represented as a right-justified character string field with a maximum length of thirty characters. This format will accommodate the extra decimal point appearing in these data for certain spacecraft and other special formats, while also supporting the need for simple comparison (e.g., ">" or <") between clock count values. ¶
¶
Note that if the spacecraft clock values are not strictly numeric strings (for example, if they contain colon separators), care should be taken in dealing with blank padding and justification of the string value. If necessary, non-numeric strings may be left-justified to ensure that clock values will sort in the expected way.¶ ... [1]

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7.4.1 Midnight

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Midnight may be indicated in one of two ways: as “00:00:00” or “24:00:00”. The usual precision modifications apply as well – i.e., “24:00” is also recognized as midnight.

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The “00:00:00” notation is used to indicate midnight at the beginning of a date. “24:00:00” is used to indicate midnight at the end of a date. So, for example, the following two date/time strings refer to precisely the same moment:

    2007-04-07T24:00:00 = 2007-04-08T00:00:00

When the hours field has the value “24”, any and all subsequent time fields *must* be zero.

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7.4.2 Leap Seconds

Leap seconds may be positive or negative, but in either case are always applied at the end of the day in question. A positive leap second is indicated with a time value of “23:59:60”. A negative leap second is indicated by the omission of the time “23:59:59”. That is, on the day of a negative leap second, the sequence leading through midnight is:

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    23:59:57
    23:59:58
    00:00:00
    00:00:01

And on the day of a positive leap second, the sequence through midnight is:

    23:59:58
    23:59:59
    23:59:60
    00:00:00
    00:00:01

Note that the *only* time when the seconds value of a time string may contain the value “60” is when this represents a positive leap second.

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The following paragraphs describe typical examples of native time formats.

1. **Spacecraft Clock Count (sclk)** - Spacecraft clock count (sclk) provides a more precise time representation than event time for instrument-generated data sets, and so may be desirable as an additional time field. In a typical instance, a range of spacecraft-clock-count values (i.e., a start-and a stop-value) may be required.

   Spacecraft clock count (SPACECRAFT_CLOCK_START_COUNT and SPACECRAFT_CLOCK_STOP_COUNT) shall be represented as a right-justified character string field with a maximum length of thirty characters. This format will accommodate the extra decimal point appearing in these data for certain spacecraft and other special formats, while also supporting the need for simple comparison (e.g., ">" or <") between clock count values.

   Note that if the spacecraft clock values are not strictly numeric strings (for example, if they contain colon separators), care should be taken in dealing with blank padding and justification of the string value. If necessary, non-numeric strings may be left-justified to ensure that clock values will sort in the expected way.

   Example

   ```
   SPACECRAFT_CLOCK_START_COUNT = " 1234:36.401"        correct
   SPACECRAFT_CLOCK_START_COUNT = "1234:36.401 "        incorrect
   ```

2. **Longitude of Sun** - Longitude of Sun ("LS") is a derived data value that can be computed, for a given target, from UTC.

3. **Ephemeris Time** - Ephemeris time (ET) is calculated as "TAI + 32.184 sec. + periodic terms". The NAIF S and P kernels have data that are in ET, but the user (via NAIF ephemeris readers which perform data conversion) can obtain the UTC values.

4. **Relative Time** - In addition to event times, certain "relative time" fields will be needed to represent data times or elapsed times. Time-from-closest-approach is an example of such a data element. These times shall be presented in a (D,H,M,S) format as a floating point number, and should include fractional seconds when necessary. The inclusion of "day" in relative times is motivated by the possible multi-day length of some delta times, as could occur, for example, in the case of the several-month Galileo Jupiter orbit.

5. **Local Times** - For a given celestial body, LOCAL_TIME is the hour relative to midnight in units of 1/24th the length of the solar day for the body.

6. **Alternate Time Zones (Relative to UTC)** - Alternate time zones (e.g., YYYY-MM-DDTHH:MM:SS.SSS + HH:MM) may not be used in a PDS label. The only allowed time formats are:

(1)YYYY-MM-DDTHH:MM:SS.SSS.
(2)YYYY-DOYTHH:MM:SS.SSS.

The above only applies to keywords with a data type of TIME. For example, START_TIME and END_TIME are defined as having keyword-values of type TIME and are subject to the above restrictions. NATIVE_START_TIME and NATIVE_STOP_TIME are defined as having keyword-values of type CHARACTER and as such can be expressed by a string of characters, including offsets to UTC).