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Navigation and Ancillary Information Facility

# Time Conversion and Time Formats

April 2023



# Topics

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- **Time Systems and Kernels**
- **Converting Time Strings**
- **Converting Numeric Times**
- **Use of Time Format Picture**
- **Additional Time Conversions**
- **Principal Time System Interfaces**



# Time Systems and Kernels

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- Time inputs to and outputs from user's programs are usually **strings** representing epochs in these three time systems:
  - Ephemeris Time (**ET**, also referred to as Barycentric Dynamical Time, **TDB**)
  - Coordinated Universal Time (**UTC**). This is the default for calendar strings.
  - Spacecraft Clock (**SCLK**)
- Time stamps in kernel files, and time inputs to and outputs from SPICE routines reading kernel data and computing derived geometry, are double precision **numbers** representing epochs in these two time systems:
  - Numeric Ephemeris Time (TDB), expressed as ephemeris seconds past J2000
    - » J2000 = 2000 Jan 1 12:00:00 TDB (<- NOT UTC)
  - Encoded Spacecraft Clock, expressed as clock ticks since the clock start
- **SPICE** provides routines to convert between these string and numeric representations.
- A time string used as an argument in a SPICE API must be provided in quotes.
  - Fortran, Matlab, IDL and Python: use single quotes
  - C and JNI: use double quotes



# Converting Time Strings (1)

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- **UTC, TDB, or TDT (TT) String to numeric Ephemeris Time**
  - **STR2ET ( *string*, *ET* )**
    - » Converts virtually any time string format known to the SPICE Time subsystem, excepting SCLK.
    - » Examples of acceptable string inputs:
      - '1996-12-18T12:28:28'
      - '1978/03/12 23:28:59.29'
      - 'Mar 2, 1993 11:18:17.287 p.m. PDT'
      - '1996-12-18T12:28:28Z'
      - '1995-008T18:28:12'
      - '1993-321//12:28:28.287'
      - '2451515.2981 JD'
      - 'jd 2451700.05 TDB'
      - '1988-08-13, 12:29:48 TDB'
      - '1992 June 13, 12:29:48 TDT'
  - Requires the LSK kernel

These example inputs all use the single quote required by Fortran, IDL, MATLAB and Python APIs. Use double quotes for C and JNI APIs.

**The SPICE Time high-level APIs interpret a calendar, DOY, or Julian date time string without an explicit time system token, "TDB", "TT", etc., as UTC.**



# Converting Time Strings (2)

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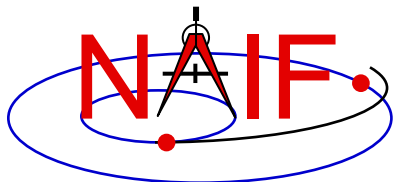
- **Spacecraft Clock String to numeric Ephemeris Time**
  - SCS2E ( *scid*, *string*, *ET* )
    - » Converts SCLK strings consistent with SCLK parameters.
    - » Examples of acceptable clock string inputs:
      - '5/65439:18:513' (VGR1)
      - '946814430.172' (MRO)
      - '1/0344476949-27365' (MSL)
  - Requires a SCLK kernel and an LSK kernel



# Converting Numeric Times (1)

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- Numeric Ephemeris Time to a string, where the format is Calendar, DOY or Julian Date, and the time system is *UTC*, *TDB* or *TDT*
  - TIMEOUT ( *et*, *fmpic*, *STRING* )
    - » *fmpic* is an output time string format specification, giving the user great flexibility in setting the appearance of the output time string and the time system used (*UTC*, *TDB*, *TDT*).
      - See the next slide for examples of format pictures to produce a variety of output time strings
      - See the TIMEOUT header for complete format picture syntax
      - The module TPICTR may be useful in constructing a format picture specification from a sample time string
  - Requires LSK Kernel



# Converting Numeric Times (2)

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## Example Time Strings and the Corresponding Format Pictures

### Common Time Strings

### Format Picture Used (*fmtpic*)

1999-03-21T12:28:29.702

YYYY-MM-DDTHR:MN:SC.###

1999-283T12:29:33

YYYY-DOYTHR:MN:SC ::RND

1999-01-12, 12:00:01.342 TDB

YYYY-MM-DD, HR:MN:SC.### ::TDB TDB

2450297.19942145 JD TDB

JULIAND.##### ::TDB JD TDB

### Less Common Time Strings

### Format Picture Used (*fmtpic*)

465 B.C. Jan 12 03:15:23 p.m.

YYYY ERA Mon DD AP:MN:SC ampm

04:28:55 A.M. June 12, 1982

AP:MN:SC AMPM Month DD, YYYY

Thursday November 04, 1999

Weekday Month DD, YYYY

DEC 31, 15:59:60.12 1998 (PST)

MON DD, HR:MN:SC.## YYYY (PST)::UTC-8



# Converting Numeric Times (3)

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- **Numeric Ephemeris Time to Spacecraft Clock String**
  - SCE2S (*scid*, *et*, SCLKCH )
    - » Output SCLK string examples:
      - 1/05812:00:001 (Voyager 1 and 2)
      - 1/1487147147.203 (Cassini, MRO)
      - 1/0101519975.65186 (MEX, VEX, Rosetta)
  - Requires a SCLK kernel and an LSK kernel



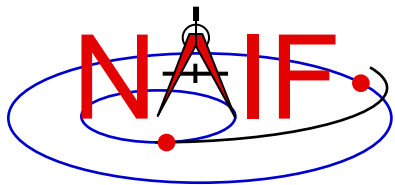


# Additional Time Conversions

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- **Numeric Ephemeris Time to Local Solar Time String**
  - ET2LST( *et*, *body*, *long*, *type*, *HR*, *MN*, *SC*, *TIME*, *AMPM* )
  - Requires SPK and PCK kernels
    - » To compute *body* position relative to the Sun and *body* rotation.
- **Numeric Ephemeris Time to planetocentric longitude of the Sun (*Ls*)**
  - *LS* = LSPCN ( *body*, *et*, *abcorr* )
    - » While *Ls* is not a time system, it is frequently used to determine *body* season for a given epoch
      - *LS* = 0° , Spring
      - *LS* = 90° , Summer
      - *LS* = 180° , Autumn
      - *LS* = 270° , Winter
  - Requires SPK and PCK kernels

} For the northern hemisphere



# Principal Time System Interfaces

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