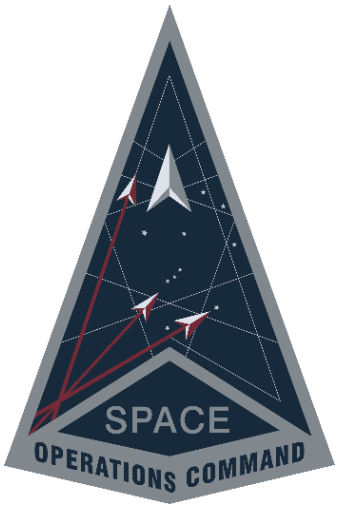
Astrodynamics Standards
Shared Library



Time Functions
(TimeFunc)

Version 9.4

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Contents

1. Introduction

TimeFunc allows the users to load and use time constants in the libraries. It also provides utility functions to convert time between different units and formats.

If you are on Windows, the shared library files will end in ".dll". For example, "TimeFunc.dll". If you are on Linux, the shared library will begin with "lib" and end in ".so", and will be all lowercase. For example, libtimefunc.so.

2. Prerequisites

The following libraries MUST be loaded and initialized before using the TimeFunc:

- DllMain
- EnvConst

3. Getting Started

To get started, please read the README.txt file that came in the root directory of your distribution. In addition to an overall description contained in the distribution, it has a description of a "**wrapper**".

To get started with **TimeFunc**, there is a "wrapper" specific to TimeFunc, under the **SampleCode** directory. Under your language of choice, you will see a "**DriverExample/wrapper**" subdirectory. The files under this directory will have all the Application Programming Interfaces (APIs) available. For TimeFunc specific APIs, you should see a source file labelled with "TimeFunc" in the file name. This will be where you will find all the APIs for that specific library. The "DriverExample" directory will also contain several examples of applications that should run by simply running the runExample.bat or runExample.sh script. You can use these examples as a starting point for building your application.

If you do not see your programming language under "SampleCode", look in the HTML documentation for the APIs. Open a browser to the "Documentation/APIDocs/index.html" file. This document will show all the APIs regardless of programming language.

The Astrodynamics Standards libraries should work with any language capable of using Dynamic Link Library (on Windows) or Shared object (on Linux) files.

4. Understanding TimeFunc

Internally, TimeFunc uses a memory buffer to store time constants. The time constants can be loaded from a main file, a time constants file, or VCM records (see VCM documentation). The time constants buffer is shared among other libraries to do time conversion between UTC, UT1, TAI, ET and to access polar wanders X and Y.

5. Abbreviations Used

The following abbreviations are used in this documentation and in TimeFunc

DS50: days since 1950. This date actually starts from 31/12/1949 00:00:00.000

UTC or Ds50UTC: days since 1950, UTC

UT1 or Ds50UT1: days since 1950, UT1

TAI or Ds50TAI: days since 1950, TAI

DTG: date time group string formats

- DTG20: YYYY/DDD HHMM SS.SSS
- DTG19: YYYYMonDDHHMMSS.SSS
- DTG17: YYYY/DDD.DDDDDDDD
- DTG15: YYDDDHHMMSS.SSS

6. Time Constants Data Description

6.1. Time Constants Input Data Formats.

Time constants can be included directly in the main input file or they can be read from a separate file identified with "TIMFIL=[pathname\filename]". They are also read in from each VCM.

This section identifies the legacy formats used for timing constants data. Timing constants data may be input as:

- Standalone records (of a restricted subset of the record types defined in this section) in a run specification file.
- A file of records of several possible types defined in this section.
- Part of the Vector/Covariance Message (VCM) described in VCM documentation, either:
  - Standalone VCM in a run specification file; or
  - File of VCMs.

Section 2 describes the TP- or ZP-Card record; Section 3 describes the SPADOC and TRACKS print format record; Section 4 describes the SPECTR print format record; and Section 5 describes the Timing Constants File. Section 6 describes the 6P Format.

6.2. "TP" or "ZP" Card Record Format

This section describes the format of the TP- or ZP-Card record.

Column	Format	Description
1	I1	time constants control flag; where: 0 = do not use time constants 1 = use time constants as input on card as specified in columns 2-76 below 2 = use time constants from the file specified in 3-74 below
2-16	D15.0	TAI - UTC (in min, if col79 = "Z", or in sec, if col 79 = "T")
17-31	D15.0	UT1 - UTC ((in min, if col 79 = "Z", or in sec, if col 79 = "T")
32-46	D15.0	UT1 - UTC rate (min/min, if col 79 = "Z", or in m-sec/day, if col 79 "T")
47-61	D15.0	TDT - TAI (in min, if col 79 = "Z", or in sec, if col 79 = "T")
62-76	D15.0	Broadcast date/time (yydddhhmmss.sss), where; yy = 50-99 for years 1950-1999 or yy = 00-49 for years 2000-2049

If Column 1 = 2:		
3-74	A72	time constants ASCII file name (def. = "tcon.tim") col 79 may be either "T" or "Z"
For Column 1 = 1 or 2:		
79	A1	required card type and units indicator ("T" or "Z")
80	A1	required card type, ("P")

6.3. SPADOC or TRACKS Print Record Format

This section describes the format of the SPADOC/TRACKS print record. Its normal use is only within a timing constants file (its format is insufficiently distinctive to be reliably recognized in a run specification file).

Column	Format	Description
1	Blank	Blank
2-11	(not read)	TRACKS file record number (not used)
12-13	I2	Year (Broadcast Time), where: yy = 50-99 for years 1950-1999 or yy = 00-49 for years 2000-2049
15-17	I3	Day of Year (Broadcast Time)
23-32	D10.0	UT1-UTC (seconds)
37-46	D10.0	UT1-UTC rate (m-sec/day)
51-60	D10.0	TAI-UTC (seconds)
65-74	D10.0	TDT-TAI (seconds)
79-80	A2	Anything EXCEPT "TP" or "ZP"

6.4. SPECTR Print Record Format

This section describes the format of the SPECTR print record. Its normal use is only within a timing constants file (its format is insufficiently distinctive to be reliably recognized in a run specification file).

Column	Format	Description
1	Blank	Blank
2-3	I2	Year (Broadcast Time), where: yy = 50-99 for years 1950-1999 or yy = 00-49 for years 2000-2049
6-8	I3	Day of Year (Broadcast Time)
22-24	D3.0	TAI-UTC (seconds)
27-34	D8.0	UT1-UTC (seconds)
37-42	F6.0	UT1-UTC rate (m-sec/day)
46-52	D7.0	Polar motion X (arc-sec)
56-62	D7.0	Polar motion Y (arc-sec)
79-80	A2	Anything EXCEPT "TP" or "ZP"

6.5. Time Constants File

This section describes the format of the Time Constants File. The file consists of an arbitrary mix of records of the following types:

- Totally blank record (ignored).
- Comment record (ignored), denoted by column 1 containing an asterisk, an upper case "C", or a lower case "c".
- TP-Card record.
- ZP-Card record.
- SPADOC/TRACKS print format record.
- SPECTR print format record.

6.6. Example Time Constants File

```
*****************************************************************************
*              ASCII TIME CONSTANTS FILE         Updated:  25 January 2000    *
*                                      TCON.TIM                               *
*****************************************************************************
*                                                                           *
*    Description:  this file contains constants to enable software to compute *
*                  the time offsets between the UTC, UT1, IAT/TAI, and TDT/ET *
*                  time standards.  They are defined as follows:            *
*                     UTC:   Broadcast or Universal Time Coordinated        *
*                            It is the defined approximation of UT2, can    *
*                            be obtained from WWV, and is subject to periodic *
```

```
*                          discontinuities, called Leap Seconds.            *
*                  UT1:    Universal Time 1 is obtained by applying cor-    *
*                          rections to sidereal time at an observing        *
*                          station for the effects of polar motion from     *
*                          the mean pole of 1905.  UT1 is a measure of the  *
*                          accumulated angle through which the earth has    *
*                          rotated at any given instant of time, and is     *
*                          the standard for most coordinate systems.        *
*                  IAT:    International Atomic Time (also known as TAI,    *
*                          or just Atomic Time) based upon the operation    *
*                          of cesium standards at various laboratories.     *
*                          It is obtained as a constant offset from TDT     *
*                          (see below), is presumed to be invariant, and    *
*                          is used as the internal time standard for        *
*                          observations, element sets, and SP integration   *
*                          within SPADOC.                                   *
*                  TDT:    Terrestrial Dynamical Time (which used to be     *
*                          called Ephemeris Time prior to 1984, was based   *
*                          upon the apparent motion of the sun, was         *
*                          determined from the motion of the moon around    *
*                          the earth, and was presumed to be uniform).      *
*                          It is now determined directly from Atomic Time:  *
*                             TDT = TAI + 32.184 seconds.                   *
*********************************************************************************
*     Timing constants may be in any (or all!) of the following formats:       *
*           (1)   TP card format; units are in seconds; denoted by 'TP'.       *
*           (2)   ZP card format; units are in minutes; denoted by 'ZP'.       *
*           (3)   SPADOC/TRACKS print format; units are in seconds; denoted    *
*                   by absence of 'TP' or 'ZP' in col 79-80, & date in 12-17.  *
*           (4)   ITT/SPECTR file format (also contains polar motion X & Y),   *
*                   denoted by absence of 'TP' or 'ZP', & date in 2-8.         *
*     The data may be preceded by a prologue (as this is), but must be       *
*         denoted by an asterisk in col 1 of every entry.                      *
*     End of file/data is denoted by an asterisk in col 1 at end of data.      *
*                                                                              *
******                                                                         *
*                                                                              *
*   1. Format of TP card:                                                      *
*      column      format       description                                    *
*==============================================================================*
*      1           A1           (blank)                                        *
*      2-16        D15.0        TAI-UTC offset (seconds)                       *
*     17-31        D15.0        UT1-UTC offset (seconds)                       *
*     32-46        D15.0        UT1-UTC rate (msec/day)                        *
*     47-61        D15.0        TDT-TAI offset (seconds)                       *
*     62-76        D15.0        Broadcast date/time (YYDDDHHMMSS.SSS); as in   *
*                                     UT1 = UTC+DUT1+DUT1R*(current-DATE)      *
*     79-80        A2           'TP' Card type & units indicator (required)    *
*********************************************************************************
*                                                                              *
*   2. Format of ZP card:                                                      *
*      column      format       description                                    *
*==============================================================================*
*      1           A1           (blank)                                        *
*      2-16        D15.0        TAI-UTC offset (minutes)                       *
*     17-31        D15.0        UT1-UTC offset (minutes)                       *
*     32-46        D15.0        UT1-UTC rate (min/min)                         *
*     47-61        D15.0        TDT-TAI offset (minutes)                       *
*     62-76   I2,I3,2I2,F6.0    Broadcast date/time (YYDDDHHMMSS.SSS); as in   *
*                                     UT1 = UTC+DUT1+DUT1R*(current-DATE)      *
*     79-80        A2           'ZP' Card type & units indicator (required)    *
*********************************************************************************
*                                                                              *
*   3. Format of SPADOC/TRACKS Time Constants Print Format:                    *
*      column      format       description                                    *
*==============================================================================*
*      1           A1           (blank)                                        *
*      2-11        (not read)   TRACKS file number (not read or used)          *
*     12-13        I2           Year (Broadcast time)                          *
*     15-17        I3           Day of year (Broadcast time)                   *
*     23-32        D10.0        UT1-UTC (seconds)                              *
*     37-46        D10.0        UT1-UTC rate (msec/day)                        *
```

```
*     51-60        D10.0        TAI-UTC (seconds)                          *
*     65-74        D10.0        TDT-TAI (seconds)                          *
*     79-80        A2           Anything EXCEPT 'TP' or 'ZP'               *
*********************************************************************************
*                                                                               *
*   4. Format of ITT/SPECTR Time Constants ASCII file Format:                   *
*      column      format       description                                    *
*===============================================================================*
*      1           A1           (blank)                                        *
*      2-3         I2           Year (Broadcast time)                          *
*      6-8         I3           Day of year (Broadcast time)                   *
*     22-24        D3.0         TAI-UTC (seconds)                              *
*     27-34        D8.0         UT1-UTC (seconds)                              *
*     37-42        D6.0         UT1-UTC rate (msec/day)                        *
*     46-52        D7.0         Polar motion X (arc-sec)                       *
*     56-62        D7.0         Polar motion Y (arc-sec)                       *
*     79-80        A2           Anything EXCEPT 'TP' or 'ZP'                   *
*********************************************************************************
*      Data (in ITT/SPECTR file format) begins:                                 *
*********************************************************************************
* DATE        DATE    TAI-  UT1-UTC UT1-UTC     POLAR MOTION                  *
*YY  DDD   DD-MMM-YY UTC            RATE        X         Y                   *
*                    (sec)  (sec)  (msec/day) (arc-s)   (arc-s)               *
*

 97  253   10-Sep-97  31   0.43191  -1.971    0.2125    0.4359
 97  263   20-Sep-97  31   0.41220  -1.895    0.2198    0.4117

* additional data goes here *

 99  161   10-Jun-99  32   0.53146  -0.824   -0.0306    0.2943
 99  171   20-Jun-99  32   0.52322  -0.577   -0.0307    0.3017
*********************************************************************************
*      Data (in SPADOC/TRACKS output file format) begins:                       *
*********************************************************************************
* FILE    BROADCAST    (UT1-UTC)     CORR. RATE    (TAI-UTC)     (TDT-TAI)
* REC.    TIME: UTC    UNIV TIME    UT1-UTC RATE  ATOMIC TIME    EPHEM TIM
* NUMB    (YY DDD)     COR (SEC)     (M-S/DAY)    CORR. (SEC)    (SEC)
*
   404     96 361       -0.10013      -1.77730      30.00000      32.18400
   403     96 351       -0.08077      -1.71040      30.00000      32.18400

* additional data goes here *

     2     86 181        0.07174      -0.92429      23.00000      32.18400
     1     86 174        0.07821      -0.89143      23.00000      32.18400
           23.0                                       32.184 85181000000.000  TP
           22.0                                       32.184 83181000000.000  TP

* additional data goes here *

           11.0                                       32.184 72182000000.000  TP
           10.0                                       32.184 72001000000.000  TP
*********************************************************************************
*       END OF DATA                                                             *
*********************************************************************************
```

7. Prediction Control (6P) Format

GENFR/SGP4/SP PROPAGATOR 6P CARD J-RELEASE 18FEB82

DESCRIPTION:

A 6P card may be used within a GENFR or SGP4/SP PROPAGATOR to specify desired times. The card may appear anywhere between the program cards.

7.1. 6P CARD FORMAT:

Column	Format	Description
1-15 Or 10-15	YYDDDHHMMSS.SSS - F6.0	Start time (date/time) - Start time in minutes since epoch
16-20	F5.0	Time interval between points, in minutes (default = 360)
22-36 Or 31-36	YYDDDHHMMSS.SSS - F6.0	Stop time (date/time) - Stop time in minutes since epoch
79-80	6P	Card identifier

7.2. 6P FREE FORMAT:

- Propagation start time in date time group format:

  START_DATE = [YY]YYDDDHHMMSS.SSS

  (also STAR_DTG)

- Propagation start time in minutes since epoch format:

  START_SINCE_EPOCH = fffff.fff

- Propagation stop time in date time group format:

  STOP_DATE = [YY]YYDDDHHMMSS.SSS

  (also STOP_DTG)

- Propagation stop time in minutes since epoch format:

  STOP_SINCE_EPOCH = fffff.fff

- Propagation interval

  INTERVAL = fff.fff (min)

  (also STEP)

Examples:

	Copy

```
* Prediction spans from YY=2001, DDD=002, HH=03, MM=04, SS.SSS=11.222
*for one day with 10-minute step size
STARTDATE = 2001002030411.222
STOP_DATE = 2001003030411.222
INTERVAL = 10

* Prediction starts from epoch for one day with 10-minute step size
*for one day with 10 minutes step size
START_SINCE_EPOCH = 0
STOP_SINCE_EPOCH=1440
INTERVAL = 10
```