NIST Time and Frequency Bulletin

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1

1. GENERAL BACKGROUND INFORMATION

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ACRONYMS AND ABBREVIATIONS USED IN THIS BULLETIN

ACTS   - Automated Computer Time Service
BIPM   - Bureau International des Poids et Mesures
GPS   - Global Positioning System
IERS   - International Earth Rotation Service
MC   - Master Clock
MJD   - Modified Julian Date
NIST   - National Institute of Standards and Technology   ns   - nanosecond
SI   - International System of Units   µs   - microsecond
TA   - Atomic Time   ms   - millisecond
TAI   - International Atomic Time   s   - second
USNO   - United States Naval Observatory   min   - minute
UT1   - Universal Time (Astronomical)
UTC   - Coordinated Universal Time

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2. TIME SCALE INFORMATION

The values listed below are based on data from the IERS, the USNO, and NIST. The UTC(USNO,MC) - UTC(NIST) values are averaged measurements from all available common-view GPS satellites (see bibliography on page 5). UTC - UTC(NIST) data are on page 3.

0000 HOURS COORDINATED UNIVERSAL TIME			
May 2020	MJD	UT1-UTC(NIST) (±5 ms)	UTC(USNO,MC) - UTC(NIST) (±20 ns)
7	58976	-247.84 ms	-6.5 ns
14	58983	-250.56 ms	-6.4 ns
21	58990	-253.61 ms	-4.6 ns
28	58997	-253.55 ms	-4.3 ns

The master clock pulses used by the WWV, WWVH, and WWVB time-code transmissions are referenced to the UTC (NIST) time scale. Occasionally, 1 s is added to the UTC time scale. This second is called a leap second. Its purpose is to keep the UTC time scale within ±0.9 s of the UT1 astronomical time scale, which changes slightly due to variations in the Earth's period of rotation.

NOTE: No leap second was added at the end of December 2019.

Positive leap seconds, beginning at 23 h 59 min 60 s UTC and ending at 0 h 0 min 0 s UTC, were inserted in the UTC time scale on 30 June 1972, 1981-1983, 1985, 1992-1994, 1997, 2012, 2015 and on 31 December 1972-1979, 1987, 1989, 1990,1995, 1998, 2005, 2008, 2016.

The use of leap seconds ensures that UT1 - UTC will always be held within ±0.9 s. The current value of UT1 - UTC is called the DUT1 correction. DUT1 corrections are broadcast by WWV, WWVH, WWVB, and ACTS and are printed below. These corrections may be added to the received UTC time signals in order to obtain UT1.

	-0.2 s beginning 0000 UTC 02 May 2019
	-0.1 s beginning 0000 UTC 17 January 2019
	+0.0 s beginning 0000 UTC 21 September 2018
	+0.1 s beginning 0000 UTC 15 March 2018
	+0.2 s beginning 0000 UTC 30 November 2017
DUT1 = UT1 - UTC =	+0.3 s beginning 0000 UTC 29 June 2017
	+0.4 s beginning 0000 UTC 30 March 2017
	+0.5 s beginning 0000 UTC 26 January 2017
	+0.6 s beginning 0000 UTC 01 January 2017
	-0.4 s beginning 0000 UTC 17 November 2016

The difference between UTC(NIST) and UTC has been within ±100 ns since July 6, 1994. The table below shows values of UTC - UTC(NIST) as supplied by the BIPM in their *Circular T* publication for the most recent 310-day period in which data are available. Data are given at ten-day intervals. Five-day interval data are available in *Circular T* .

0000 Hours Coordinated Universal Time		
DATE	MJD	UTC-UTC(NIST), ns
May 30, 2020	58999	-2.4
May 20, 2020	58989	-2.4
May 10, 2020	58979	-2.3
Apr. 30, 2020	58969	-1.7
Apr. 20, 2020	58959	-1.1
Apr. 10, 2020	58949	-0.7
Mar. 31, 2020	58939	-1
Mar. 21, 2020	58929	-0.7
Mar. 11, 2020	58919	0.1
Mar. 1, 2020	58909	0.1
Feb. 20, 2020	58899	1.5
Feb. 10, 2020	58889	2.2
Jan. 31, 2020	58879	1.5
Jan. 21, 2020	58869	0.6
Jan. 11, 2020	58859	-2
Jan. 1, 2020	58849	-0.8
Dec. 22, 2019	58839	2.8
Dec. 12, 2019	58829	1.2
Dec. 2, 2019	58819	0.4
Nov. 22, 2019	58809	0.7
Nov. 12, 2019	58799	0.1
Nov. 2, 2019	58789	0.8
Oct. 23, 2019	58779	2.4
Oct. 13, 2019	58769	1.1
Oct. 3, 2019	58759	0.6
Sep. 23, 2019	58749	1.1
Sep. 13, 2019	58739	1
Sep. 3, 2019	58729	0.6
Aug. 24, 2019	58719	0.3
Aug. 14, 2019	58709	-0.1
Aug. 4, 2019	58699	-0.1
July 25, 2019	58689	1.2
July 15, 2019	58679	1.2

3.   BROADCAST OUTAGES OVER FIVE MINUTES AND WWVB PHASE PERTURBATIONS

	OUTAGES OF 5 MINUTES OR MORE					PHASE PERTURBATIONS 2 ms			
Station	May 2020	MJD	Began UTC	Ended UTC	Freq.	May 2020	MJD	Began UTC	End UTC
WWVB	31 25 01	59000 58994 58970	2252 1003 0311	2313 1034 0333	60 kHz 60 kHz 60 kHz	None			
WWV	20	58989	0122	0226	5 MHz	None			
WWVH	None					None			

4.   NOTES ON NIST TIME SCALES AND PRIMARY STANDARDS

Primary frequency standards developed and operated by NIST are used to provide accuracy (rate) input to the BIPM and to provide the best possible realization of the SI second. NIST-F1 and NIST-F2, cold-atom cesium fountain frequency standards, have served as the U.S. primary standards of time and frequency since 1999. The uncertainty of NIST-F2 is currently about 1 part in 10^{16}.

The AT1 scale is run in real-time by use of data from an ensemble of cesium standards and hydrogen masers. It is a free-running scale whose frequency is maintained as nearly constant as possible by choosing the optimum weight for each clock that contributes to the computation.

UTC is generated at the BIPM by use of a post-processed time-scale algorithm and is not available in real-time. The parameters that we use to generate UTC(NIST) in real-time are therefore based on an extrapolation of UTC from the most recent available data.

UTC(NIST) is generated as an offset from our real-time scale AT1. Time steps are never used. Instead, the frequency is steered so that the time output remains close to UTC. This is accomplished by using data published by the BIPM in its *Circular T* and by weekly estimates of UTC, which are published by the BIPM as *rapid UTC* or *UTCr*. Changes in the frequency may be made as often as once per week and are limited to ±2.3 x 10^{-14}. The frequency of UTC(NIST) is kept as stable as possible at other times.

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5.   UTC(NIST) – AT1 PARAMETERS

The table below lists parameters that are used to define UTC(NIST) with respect to our real-time scale AT1. To find the value of UTC(NIST) - AT1 at any time T (expressed as a Modified Julian Date, including a fraction if needed), the appropriate equation to use is the one for which the desired T is greater than or equal to the entry in the T_0 column and less than the entry in the last column. The values of x_{ls}, x, and y for that month are then used in the equation below to find the desired value. The parameters x and y represent the offsets in time and frequency, respectively, between UTC(NIST) and AT1; the parameter x_{ls} is the number of leap seconds applied to both UTC(NIST) and UTC, as specified by the IERS. Leap seconds are not applied to AT1.

UTC(NIST) - AT1 = x_{ls} + x + $y (T - T_0)$					
Month	x_{ls} (s)	x (ns)	y (ns/d)	T_0 (MJD)	Valid until 0000 on: (MJD)
May 20	-37	-485384.85	-37.2	58983	59001
May 20	-37	-484903.85	-37	58970	58983
Apr 20	-37	-483793.85	-37	58940	58970
Mar 20	-37	-482646.85	-37	58909	58940
Feb 20	-37	-482535.85	-37.00†	58906	58909
Feb 20	-37	-482020.65	-36.80†	58892	58906
Feb 20	-37	-481576.65	-37	58880	58892
Jan 20	-37	-481243.65	-37.00	58871	58880
Jan 20	-37	-480465.95	-36.80†	58850	58871
Jan 20	-37	-480429.45	-36.50	58849	58850
Dec 19	-37	-480210.45	-36.50†	58843	58849
Dec 19	-37	-479989.95	-36.75†	58837	58843
Dec 19	-37	-479284.10	-37.15	58818	58837
Nov 19	-37	-478912.60	-37.15†	58808	58818
Nov 19	-37	-478389.70	-37.35†	58794	58808
Nov 19	-37	-478167.40	-37.05*	58788	58794
Oct 19	-37	-477871.00	-37.05	58780	58788*
Oct 19	-37	-477011.95	-37.35	58757	58780†
Sep 19	-37	-475891.45	-37.35	58727	58757
Aug 19	-37	-474995.05	-37.35	58703	58727
Aug 19	-37	-474735.35	-37.10	58696	58703†
Jul 19	-37	-473696.55	-37.10	58668	58696
Jul 19	-37	-473584.35	-37.40	58665	58668†
Jun 19	-37	-473172.95	-37.40	58654	58665
Jun 19	-37	-472949.75	-37.20	58648	58654†
Jun 19	-37	-472469.4	-36.95	58635	58648†
May 19	-37	-471878.2	-36.95	58619	58635
May 19	-37	-471327.7	-36.70	58604	58619†
Apr 19	-37	-471107.5	-36.70	58598	58604
Apr 19	-37	-470592.3	-36.80	58584	58598†
Apr 19	-37	-470222.3	-37.00	58574	58584†

† **Rate change in mid-month**

*Provisional value