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NIST Time and Frequency Bulletin

Petrina C. Potts, Editor

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U.S. Department of Commerce
Penny Pritzker, Secretary

National Institute of Standards and Technology
Willie E. May, Acting Under Secretary of Commerce for Standards and Technology and Acting Director

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1. GENERAL BACKGROUND INFORMATION

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		

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			
Dec 2014	MJD	UT1-UTC(NIST) (±5 ms)	UTC(USNO,MC) - UTC(NIST) (±20 ns)
4	56995	-427 ms	+11 ns
11	57002	-434 ms	+11 ns
18	57009	-443 ms	+9 ns
25	57016	-450 ms	+9 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: A positive leap second will be added at the end of June 2015.

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, and 2012, and on 31 December 1972-1979, 1987, 1989, 1990,1995, 1998, 2005, and 2008.

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 received UTC time signals in order to obtain UT1.

DUT1 = UT1 - UTC =

-0.5 s beginning 0000 UTC 25 December 2014
-0.4 s beginning 0000 UTC 25 September 2014
-0.3 s beginning 0000 UTC 08 May 2014
- 0.2 s beginning 0000 UTC 20 February 2014
- 0.1 s beginning 0000 UTC 21 November 2013
+0.0 s beginning 0000 UTC 22 August 2013
+0.1 s beginning 0000 UTC 11 April 2013
+0.2 s beginning 0000 UTC 31 January 2013
+0.3 s beginning 0000 UTC 25 October 2012
+0.4 s beginning 0000 UTC 01 July 2012
- 0.6 s beginning 0000 UTC 10 May 2012
- 0.5 s beginning 0000 UTC 09 February 2012
- 0.4 s beginning 0000 UTC 04 November 2011
- 0.3 s beginning 0000 UTC 12 May 2011
- 0.2 s beginning 0000 UTC 06 January 2011
- 0.1 s beginning 0000 UTC 03 June 2010

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
Nov.28, 2014	56989	11.1
Nov. 18, 2014	56979	11.6
Nov. 08, 2014	56969	12.2
Oct. 29, 2014	56959	10.9
Oct. 19, 2014	56949	10.6
Oct 9, 2014	56939	9.3
Sep. 29, 2014	56929	7.2
Sep. 19, 2014	56919	5.6
Sep. 9, 2014	56909	4.8
Aug. 30, 2014	56899	4.6
Aug. 20, 2014	56889	3.8
Aug. 10, 2014	56879	4.1
July 31, 2014	56869	4.5
July 21, 2014	56859	4.9
July 11, 2014	56849	5.0
July 1, 2014	56839	5.1
June 21, 2014	56829	4.8
June 11, 2014	56819	5.4
June 1, 2014	56809	6.4
May 22, 2014	56799	6.0
May 12, 2014	56789	5.9
May 2, 2014	56779	5.5
Apr. 22, 2014	56769	5.2
Apr. 12, 2014	56759	5.5
Apr. 2, 2014	56749	6.0
Mar 23, 2014	56739	5.8
Mar. 13, 2014	56729	6.3
Mar. 03, 2014	56719	5.7
Feb. 21, 2014	56709	5.1
Feb. 11, 2014	56699	4.3
Feb. 1, 2014	56689	3.2

3. BROADCAST OUTAGES OVER FIVE MINUTES AND WWVB PHASE PERTURBATIONS

OUTAGES OF 5 MINUTES OR MORE						PHASE PERTURBATIONS 2 ms			
Station	Dec 2014	MJD	Began UTC	Ended UTC	Freq.	Dec 2014	MJD	Began UTC	End UTC
WWVB	12/21/14	57012	1946	2042	60 Khz				
WWV									
WWVH									

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, a cold-atom cesium fountain frequency standard, has served as the U.S. primary standard of time and frequency since 1999. The uncertainty of NIST-F1 is currently about 3 parts 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(NIST) is generated as an offset from our real-time scale AT1. It is steered in frequency towards UTC by use of data published by the BIPM in its *Circular T*. Changes in the steering frequency will be made, if necessary, at 0000 UTC on the first day of the month, and occasionally at mid-month. A change in frequency is limited to no more than ±2 ns/day. The frequency of UTC(NIST) is kept as stable as possible at other times.

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.

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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	xls (s)	x (ns)	y (ns/d)	T0 (MJD)	Valid until 0000 on: (MJD)
Mar 15	-35	-415010.45	-37.1*	57082	57113
Feb 15	-35	-413971.65	-37.1	57054	57082*
Jan 15	-35	-412824.65	-37.0	57023	57054
Dec 14	-35	-412010.65	-37.0	57001	57023
Dec 14	-35	-411675.85	-37.2	56992	57001†
Nov 14	-35	-410931.85	-37.2	56972	56992
Nov 14	-35	-410557.85	-37.4	56962	56972†
Oct 14	-35	-409735.05	-37.4	56940	56962
Oct 14	-35	-409379.1	-37.55*	56931	56940†
Sep 14	-35	-408270.6	-37.55	56901	56931
Aug 14	-35	-407106.6	-37.55	56870	56901
Jul 14	-35	-405942.5	-37.55	56839	56870
Jun 14	-35	-404816	-37.55	56809	56839
May 14	-35	-403651.9	-37.55	56778	56809
Apr 14	-35	-402525.4	-37.55	56748	56778
Mar 14	-35	-401624.2	-37.55	56724	56748
Mar 14	-35	-401360.7	-37.65	56717	56724†
Feb 14	-35	-400306.5	-37.65	56689	56717
Jan 14	-35	-399136.3	-37.75	56658	56689
Dec 13	-35	-397966.0	-37.75	56627	56658
Nov 13	-35	-397664.0	-37.75	56619	56627
Nov 13	-35	-396836.8	-37.6	56597	56619†
Oct 13	-35	-395677.4	-37.4	56566	56597

† Rate change in mid-month

***Provisional value**