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NIST Time and Frequency Bulletin

Petrina C. Potts, Editor

National Institute of
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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			
JUN 2013	MJD	UT1-UTC(NIST) (±5 ms)	UTC(USNO,MC) - UTC(NIST) (±20 ns)
6	56449	+71 ms	+10 ns
13	56456	+69 ms	+12 ns
20	56463	+64 ms	+15 ns
27	56470	+59 ms	+16 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 will be added at the end of December 2013.

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 =

+0.1 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
+0.0 s beginning 0000 UTC 11 March 2010
+0.1 s beginning 0000 UTC 12 November 2009
+0.2 s beginning 0000 UTC 11 June 2009
+0.3 s beginning 0000 UTC 12 March 2009

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 27, 2013	56439	6.4
May 17, 2013	56429	4.3
May 7, 2013	56419	-0.6
Apr. 27, 2013	56409	-4.8
Apr. 17, 2013	56399	-8.9
Apr. 7, 2013	56389	-11.9
Mar. 28, 2013	56379	-14.4
Mar. 18, 2013	56369	-16.5
Mar. 8, 2013	56359	-17.9
Feb. 26, 2013	56349	-18.5
Feb. 16, 2013	56339	-20.2
Feb. 6, 2013	56329	-19.0
Jan. 27, 2013	56319	-16.8
Jan. 17, 2013	56309	-14.8
Jan. 7, 2013	56299	-11.8
Dec. 28, 2012	56289	-9.5
Dec. 18, 2012	56279	-6.6
Dec. 8, 2012	56269	-4.7
Nov. 28, 2012	56259	-3.1
Nov. 18, 2012	56249	-1.3
Nov. 8, 2012	56239	-1.4
Oct. 29, 2012	56229	0.5
Oct. 19, 2012	56219	2.5
Oct. 9, 2012	56209	2.8
Sep. 29, 2012	56199	2.9
Sep. 19, 2012	56189	3.9
Sep. 9, 2012	56179	3.3
Aug. 30, 2012	56169	2.8
Aug. 20, 2012	56159	2.7
Aug. 10, 2012	56149	2.8

3. BROADCAST OUTAGES OVER FIVE MINUTES AND WWVB PHASE PERTURBATIONS

OUTAGES OF 5 MINUTES OR MORE						PHASE PERTURBATIONS 2 ms			
Station	Jun 2013	MJD	Began UTC	Ended UTC	Freq.	Jun 2013	MJD	Began UTC	End UTC
WWVB	06-16-13	56459	0035	0129	60 kHz				
	06-16-13	56459	2035	2152	60 kHz				
	06-28-13	56471	0813	0928	60 kHz				
	06-29-13	56472	0152	0345	60 kHz				
	06-30-13	56473	0735	0838	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.

References:

Allan, D.W.; Hellwig, H.; and Glaze, D.J., "An accuracy algorithm for an atomic time scale," Metrologia, Vol.11, No.3, pp. 133-138 (1975).

Allan, D.W.; Davis, D.D.; Weiss, M.A.; Clements, A.; Guinot, B.; Granveaud, M.; Dorenwendt, K.; Fischer, B.; Hetzel, P.; Aoki, S.; Fujimoto, M.; Charron, L.; and Ashby, N., “Accuracy of international time and frequency comparisons via global positioning system satellites in common-view,” IEEE Transactions on Instrumentation and Measurement, Vol. IM-34, pp.118-125 (1985).

Heavner, T.P.; Jefferts, S.R.; Donley; E.A.; Shirley, J.H. and Parker, T.E., “NIST F1; recent improvements and accuracy evaluations,” Metrologia, Vol. 42, pp. 411-422 (2005).

Jefferts, S.R.; Shirley, J.; Parker, T.E.; Heavner, T.P.; Meekhof, D.M.; Nelson, C., Levi, F.; Costanza, G.; De Marchi, A.; Drullinger, R.; Hollberg, L.; Lee, W.D.; and Walls, F.L., “Accuracy evaluation of NIST-F1,” Metrologia, Vol. 39, pp. 321-336 (2002).

Lewandowski, W. and Thomas, C., “GPS Time transfer,” Proceedings of the IEEE, Vol. 79, pp. 991-1000 (1991).

Parker, T.E.; Jefferts, S.R.; Heavner, T.P.; and Donley, E.A., “Operation of the NIST-F1 caesium fountain primary frequency standard with a maser ensemble, including the impact of frequency transfer noise,” Metrologia, Vol. 42, pp. 423-430 (2005).

Weiss, M.A.; Allan, D.W., “An NBS Calibration Procedure for Providing Time and Frequency at a Remote Site by Weighting and Smoothing of GPS Common View Data,” IEEE Transactions on Instrumentation and Measurement, Vol. IM-36, pp. 572-578 (1987).

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)
Aug 13	-13	-393386.0	-37.8*	56505	56536
Jul 13	-35	-392554.4	-37.8	56483	56505
Jul 13	-35	-392213.3	-37.9	56474	56483†
Jun 13	-35	-391070.3	-38.1	56444	56474
May 13	-35	-390689.3	-38.1	56434	56444
May 13	-35	-389882.9	-38.4	56413	56434†
Apr 13	-35	-388730.9	-38.4	56383	56413
Mar 13	-35	-388308.5	-38.4	56372	56383
Mar 13	-35	-387542.5	-38.3	56352	56372†
Feb 13	-35	-387044.6	-38.3	56339	56352
Feb 13	-35	-386474.6	-38.0	56324	56339†
Jan 13	-35	-385828.6	-38.0	56307	56324
Jan 13	-35	385300.8	-37.7	56293	56307†
Dec 12	-35	-384132.1	-37.7	56262	56293
Nov 12	-35	-383001.1	-37.7	56232	56262
Oct 12	-35	-381832.4	-37.7	56201	56232
Sep 12	-35	-380701.4	-37.7	56171	56201
Aug 12	-35	-379532.7	-37.7	56140	56171
Jul 12	***-35***	-3783640	-37.7	56109	56140
Jun 12	-34	-377233	-37.7	56079	56109
May 12	-34	-376705.2	-37.7	56065	56079
May 12	-34	-376059.2	-38	56048	56065†
Apr 12	-34	-374919.2	-38	56018	56048

† Rate change in mid-month

***Provisional value**