NISTIR 7980-03

NIST Time and Frequency Bulletin

Petrina C. Potts, Editor

http://dx.doi.org/10.6028/NIST.IR.7980-03

National Institute of Standards and Technology
U.S. Department of Commerce

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March 2014

U.S. Department of Commerce
Penny Pritzker, Secretary

National Institute of Standards and Technology
Patrick D. Gallagher, Under Secretary of Commerce for Standards and Technology and Director

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No. 675 March 2014

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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
SI - International System of Units
TA - Atomic Time
TAI - International Atomic Time
USNO - United States Naval Observatory
UT1 - Universal Time (Astronomical)
UTC - Coordinated Universal Time

ns - nanosecond
µs - microsecond
ms - millisecond
s - second
min - minute

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			
FEB 2014	MJD	UT1-UTC(NIST) (±5 ms)	UTC(USNO,MC) - UTC(NIST) (±20 ns)
6	56694	-135 ms	+5 ns
13	56701	-104 ms	+6 ns
20	56708	-149 ms	+7 ns
27	56715	-157 ms	+6 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 June 2014.

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 =

- 0.2 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
+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

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**
Jan. 22, 2014	**56679**	**2.1**
Jan. 12, 2014	**56669**	**0.6**
Jan. 2, 2014	**56659**	**-0.7**
Dec. 23, 2013	**56649**	**-2.6**
Dec. 13, 2013	**56639**	**-4.6**
Dec. 3, 2013	**56629**	**-5.1**
Nov. 23. 2013	**56619**	**-5.9**
Nov. 13, 2013	**56609**	**-4.8**
Nov. 3, 2013	**56599**	**-2.8**
Oct. 24, 2013	**56589**	**1.1**
Oct. 14, 2013	**56579**	**3.8**
Oct. 4, 2013	**56569**	**6.9**
Sep. 24, 2013	**56559**	**10.9**
Sep. 14, 2013	**56549**	**13.1**
Sep. 4, 2013	**56539**	**13.9**
Aug. 25, 2013	**56529**	**14.0**
Aug. 15, 2013	**56519**	**14.5**
Aug. 5, 2013	**56509**	**14.6**
Jul. 26, 2013	**56499**	**14.4**
Jul. 16, 2013	**56489**	**14.0**
Jul. 6, 2013	**56479**	**13.5**
Jun. 26, 2013	**56469**	**12.3**
Jun. 16, 2013	**56459**	**9.8**
Jun. 6, 2013	**56449**	**7.9**
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**

3. BROADCAST OUTAGES OVER FIVE MINUTES AND WWVB PHASE PERTURBATIONS

OUTAGES OF 5 MINUTES OR MORE						PHASE PERTURBATIONS 2 ms			
Station	Feb 2014	MJD	Began UTC	Ended UTC	Freq.	Feb 2014	MJD	Began UTC	End UTC
WWVB	02/11/14	56699	2324	2337	60 kHz				
	02/09/14	56697	1906	2006	60 kHz				
	02/06/14	56694	0638	0745	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)
May 14	-35	-403651.95	-37.55*	56778	56809
Apr 14	-35	-402525.45	-37.55	56748	56778*
Mar 14	-35	-401624.25	-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
Sep 13	-35	-394929.4	-37.4	56546	56566
Sep 13	-35	-394553.4	-37.6	56236	56546†
Aug 13	-35	-393726.2	-37.6	56514	56536
Aug 13	-35	-393386.0	-37.8	56505	56514†
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†

† **Rate change in mid-month**

***Provisional value**