

NISTIR 8044-09

NIST Time and Frequency Bulletin

Karen Hansen Lichtfuss, Editor

<http://dx.doi.org/10.6028/NIST.IR.8044-09>

NISTIR 8044-09

NIST Time and Frequency Bulletin

*Karen Hansen Lichtfuss, Editor
Time and Frequency Division
Physical Measurement Laboratory*

<http://dx.doi.org/10.6028/NIST.IR.8044-09>

September 2015



U.S. Department of Commerce
Penny Pritzker, Secretary

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

NIST TIME AND FREQUENCY BULLETIN
NIST IR 8044-09

No. 694 September 2015

1. GENERAL BACKGROUND INFORMATION.....	2
2. TIME SCALE INFORMATION	2
3. BROADCAST OUTAGES OVER FIVE MINUTES AND WWVB PHASE PERTURBATIONS.....	4
4. NOTES ON NIST TIME SCALES AND PRIMARY STANDARDS.....	4
5. UTC (NIST) – AT1 PARAMETERS	5

This bulletin is published monthly. Address correspondence to:

Karen Hansen Lichtfuss, Editor
Time and Frequency Division
National Institute of Standards and Technology
325 Broadway
Boulder, CO 80305-3328
(303) 497-3295
Email: karen.hansenlichtfuss@nist.gov



U.S. DEPARTMENT OF COMMERCE, Penny Pritzker, Secretary
NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY, Willie E. May, Under Secretary of Commerce for
Standards and Technology and Director

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			
August 2015	MJD	UT1-UTC(NIST) (±5 ms)	UTC(USNO,MC) - UTC(NIST) (±20 ns)
6	57240	+ 296 ms	+ 10 ns
13	57247	+ 290 ms	+ 10 ns
20	57254	+ 285 ms	+ 13 ns
27	57261	+ 279 ms	+ 11 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 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, 2012, 2015 and on 31 December 1972-1979, 1987, 1989, 1990, 1995, 1998, 2005, 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 the received UTC time signals in order to obtain UT1.

DUT1 = UT1 - UTC =	+ 0.3 s beginning 0000 UTC 01 July 2015
	-0.7 s beginning 0000 UTC 28 May 2015
	-0.6 s beginning 0000 UTC 19 March 2015
	-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

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
Jul 26, 2015	57229	9.4
Jul 16, 2015	57219	8.8
Jul 6, 2015	57209	7.7
Jun 26, 2015	57199	6.6
Jun 16, 2015	57189	6.3
Jun 6, 2015	57179	5.8
May 27, 2015	57169	5.6
May 17, 2015	57159	4.7
May 7, 2015	57149	4.8
Apr. 27, 2015	57139	4.4
Apr. 17, 2015	57129	4.4
Apr. 07, 2015	57119	4.5
Mar. 28, 2015	57109	4.3
Mar. 18, 2015	57099	4.3
Mar. 8, 2015	57089	4.2
Feb. 26, 2015	57079	3.5
Feb. 16, 2015	57069	2.5
Feb. 06, 2015	57059	2.5
Jan. 27, 2015	57049	3.5
Jan. 17, 2015	57039	5.0
Jan. 7, 2015	57029	5.8
Dec. 28, 2014	57019	7.8
Dec. 18, 2014	57009	9.6
Dec. 8, 2014	56999	10.2
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

3. BROADCAST OUTAGES OVER FIVE MINUTES AND WWVB PHASE PERTURBATIONS

OUTAGES OF 5 MINUTES OR MORE						PHASE PERTURBATIONS 2 ms			
Station	August 2015	MJD	Began UTC	Ended UTC	Freq.	August 2015	MJD	Began UTC	End UTC
WWVB	None					None			
WWV	None					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 F-2, 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(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	x_{ls} (s)	x (ns)	y (ns/d)	T_0 (MJD)	Valid until 0000 on: (MJD)
Nov 15	-36	-424074.25	-36.6*	57327	57357
Oct 15	-36	-422939.65	-36.6	57296	57327*
Sep 15	-36	-421832.65	-36.9	57266	57296
Aug 15	-36	-421057.75	-36.9	57245	57266
Aug 15	-36	-420686.75	-37.1	57235	57245†
Jul 15	-36	-419536.65	-37.1	57204	57235
Jun 15	-35	-418423.65	-37.1	57174	57204
May 15	-35	-417273.55	-37.1	57143	57174
Apr 15	-35	-416161.55	-37.1	57113	57143
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

† Rate change in mid-month

*Provisional value