

NIST TIME AND FREQUENCY BULLETIN
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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		
CS	- Cesium Standard		
GPS	- Global Positioning System		
IERS	- International Earth Rotation Service		
LORAN	- Long Range Navigation		
MC	- Master Clock		
MJD	- Modified Julian Date		
NIST	- National Institute of Standards and Technology		
NOAA	- National Oceanic and Atmospheric Administration		
NVLAP	- National Voluntary Laboratory Accreditation Program	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
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			
SEP 2011	MJD	UT1-UTC(NIST) (±5 ms)	UTC(USNO,MC) - UTC(NIST) (±20 ns)
1	55805	-298 ms	+8 ns
8	55812	-301 ms	+8 ns
15	55819	-305 ms	+7 ns
22	55826	-309 ms	+7 ns
29	55833	-319 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 December 2011.

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, and 1997, 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.

$$DUT1 = UT1 - UTC =$$

- 0.4 s beginning 0000 UTC 29 September 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
Aug. 26, 2011	55799	8.8
Aug. 16, 2011	55789	6.9
Aug. 6, 2011	55779	5.9
July 27, 2011	55769	4.1
July 17, 2011	55759	4.3
July 7, 2011	55749	2.9
June 27, 2011	55739	2.1
June 17, 2011	55729	3.4
June 7, 2011	55719	4.6
May 28, 2011	55709	4.8
May 18, 2011	55699	6.5
May 8, 2011	55689	7.9
Apr. 28, 2011	55679	8.6
Apr. 18, 2011	55669	10.3
Apr. 8, 2011	55659	12
Mar. 29, 2011	55649	10.8
Mar. 19, 2011	55639	10.3
Mar. 9, 2011	55629	9.5
Feb. 27, 2011	55619	9.4
Feb. 17, 2011	55609	9.8
Feb. 7, 2011	55599	10.2
Jan. 28, 2011	55589	9.1
Jan. 18, 2011	55579	9.1
Jan. 8, 2011	55569	8.2
Dec. 29, 2010	55559	6.7
Dec. 19, 2010	55549	5.5
Dec. 9, 2010	55539	3.9
Nov. 29, 2010	55529	0.9
Nov. 19, 2010	55519	1.1
Nov. 9, 2010	55509	-0.6

3. BROADCAST OUTAGES OVER FIVE MINUTES AND WWVB PHASE PERTURBATIONS

OUTAGES OF 5 MINUTES OR MORE						PHASE PERTURBATIONS 2 ms			
Station	Sep 2011	MJD	Began UTC	Ended UTC	Freq.	Sep 2011	MJD	Began UTC	End UTC
WWVB									
WWV	09-04-11	55808	0607	0719	5MHz				
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. 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 Day, 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 11	-34	-369161.6	-38.0*	55866	55896
Oct 11	-34	-367983.6	-38.0	55835	55866*
Sep 11	-34	-367185.6	-38.0	55814	55835
Sep 11	-34	-366841.8	-38.2	55805	55814†
Aug 11	-34	-365654.5	-38.3	55774	55805
Jul 11	-34	-364467.2	-38.3	55743	55774
Jun 11	-34	-363318.2	-38.3	55713	55743
May 11	-34	-362130.9	-38.3	55682	55713
Apr 11	-34	-361288.3	-38.3	55660	55682
Apr 11	-34	-360980.3	-38.5	55652	55660†
Mar 11	-34	-359786.8	-38.5	55621	55652
Feb 11	-34	-359286.3	-38.5	55608	55621
Feb 11	-34	-358707.3	-38.6	55593	55608†
Jan 11	-34	-357896.7	-38.6	55572	55593
Jan 11	-34	-357508.7	-38.8	55562	55572†
Dec 10	-34	-356305.9	-38.8	55531	55562
Nov 10	-34	-355141.9	-38.8	55501	55531
Oct 10	-34	-354365.9	-38.8	55481	55401
Oct 10	-34	-353941.3	-38.6	55470	55481†
Sep 10	-34	-353285.1	-38.6	55453	55470
Sep 10	-34	-352780.7	-38.8	55440	55470†
Aug 10	-34	-351577.9	-38.8	55409	55440
Jul 10	-34	-350957.1	-38.8	55393	55409
Jul 10	-34	-350378.1	-38.6	55378	55393†

† Rate change in mid-month

*Provisional value