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# NIST Time and Frequency Bulletin

Petrina C. Potts, Editor

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*Physical Measurement Laboratory*

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U.S. Department of Commerce
*Rebecca Blank, Acting Secretary*

National Institute of Standards and Technology
*Patrick D. Gallagher, Under Secretary of Commerce for Standards and Technology and 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
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 | | | |
|---|---|---|---|
| APR 2013 | MJD | UT1-UTC(NIST) (±5 ms) | UTC(USNO,MC) - UTC(NIST) (±20 ns) |
| 4 | 56386 | +155 ms | -9 ns |
| 11 | 56393 | +140 ms | -5 ns |
| 18 | 56400 | +132 ms | -5 ns |
| 25 | 56407 | +121 ms | -4 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 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<br>+0.2 s beginning 0000 UTC 31 January 2013<br>+0.3 s beginning 0000 UTC 25 October 2012<br>+0.4 s beginning 0000 UTC 01 July 2012<br>- 0.6 s beginning 0000 UTC 10 May 2012<br>- 0.5 s beginning 0000 UTC 09 February 2012<br>- 0.4 s beginning 0000 UTC 04 November 2011<br>- 0.3 s beginning 0000 UTC 12 May 2011<br>- 0.2 s beginning 0000 UTC 06 January 2011<br>- 0.1 s beginning 0000 UTC 03 June 2010<br>+0.0 s beginning 0000 UTC 11 March 2010<br>+0.1 s beginning 0000 UTC 12 November 2009<br>+0.2 s beginning 0000 UTC 11 June 2009<br>+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** |
| **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** |
| **Jul. 31, 2012** | **56139** | **2.3** |
| **Jul. 21, 2012** | **56129** | **2.9** |
| **Jul. 11, 2012** | **56119** | **3.5** |
| **Jul. 1, 2012** | **56109** | **4.8** |
| **Jun. 21, 2012** | **56099** | **5.5** |
| **Jun. 11, 2012** | **56089** | **7.8** |
| **Jun. 1, 2012** | **56079** | **9.3** |

## 3. BROADCAST OUTAGES OVER FIVE MINUTES AND WWVB PHASE PERTURBATIONS

| OUTAGES OF 5 MINUTES OR MORE | | | | | | PHASE PERTURBATIONS 2 ms | | | |
|---|---|---|---|---|---|---|---|---|---|
| Station | Apr 2013 | MJD | Began UTC | Ended UTC | Freq. | Apr 2013 | MJD | Began UTC | End UTC |
| WWVB | 04-06-13 | 56388 | 1215 | 1315 | 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) |
|---|---|---|---|---|---|
| Jun 13 | -35 | -391073.3 | -38.4* | 56444 | 56474 |
| May 13 | -35 | -389882.9 | -38.4 | 56413 | 56444* |
| 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 |
| Mar 12 | -34 | -373741.2 | -38 | 55987 | 56018 |
| Feb 12 | -34 | -373399.2 | -38 | 55978 | 55987 |
| Feb 12 | -34 | -372643.2 | -37.8 | 55958 | 55978† |

† **Rate change in mid-month**

***Provisional value**