

NISTIR 8205-05

NIST Time and Frequency Bulletin

Kathryn Stephenson, Editor

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May 2018



U.S. Department of Commerce
Wilbur L. Ross, Jr., Secretary

National Institute of Standards and Technology
Walter Copan, NIST Director and Under Secretary of Commerce for Standards and Technology

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NIST IR 8205-05

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This bulletin is published monthly. Address correspondence to:

Kathryn Stephenson, Editor
Time and Frequency Division
National Institute of Standards and Technology
325 Broadway
Boulder, CO 80305
(303) 497-3295
Email: kathryn.stephenson@nist.gov



U.S. DEPARTMENT OF COMMERCE, Wilbur L. Ross, Jr., Secretary
NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY, Walter Copan, NIST Director
and Under Secretary of Commerce for Standards and Technology

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			
Apr 2018	MJD	UT1-UTC(NIST) (±5 ms)	UTC(USNO,MC) - UTC(NIST) (±20 ns)
05	58213	402 ms	-3.4 ns
12	58220	413 ms	-2.5 ns
19	58227	423 ms	-4.7 ns
26	58234	432 ms	-56.6 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 2018.

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, 2016.

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.

$$\text{DUT1} = \text{UT1} - \text{UTC} =$$

+0.1 s beginning 0000 UTC 15 March 2018
+0.2 s beginning 0000 UTC 30 November 2017
+0.3 s beginning 0000 UTC 29 June 2017
+0.4 s beginning 0000 UTC 30 March 2017
+0.5 s beginning 0000 UTC 26 January 2017
+0.6 s beginning 0000 UTC 01 January 2017
-0.4 s beginning 0000 UTC 17 November 2016
-0.3 s beginning 0000 UTC 01 September, 2016
-0.1 s beginning 0000 UTC 24 March 2016
+0.0 s beginning 0000 UTC 31 January 2016

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
Apr. 21, 2018	58229	-1.5
Apr. 11, 2018	58219	0.1
Apr. 1, 2018	58209	1.2
Mar. 22, 2018	58199	-0.7
Mar. 12, 2018	58189	-2.9
Mar. 2, 2018	58179	-2.6
Feb 20, 2018	58169	-1.0
Feb. 10, 2018	58159	0.1
Jan. 31, 2018	58149	-0.3
Jan. 21, 2018	58139	-0.9
Jan. 11, 2018	58129	0.1
Jan. 1, 2018	58119	-0.8
Dec. 22, 2017	58109	-0.3
Dec. 12, 2017	58099	1.4
Dec. 2, 2017	58089	0.4
Nov. 22, 2017	58079	-0.8
Nov. 12, 2017	58069	-0.1
Nov. 2, 2017	58059	0.9
Oct. 23, 2017	58049	-0.3
Oct. 13, 2017	58039	-0.3
Oct. 3, 2017	58029	0.6
Sept. 23, 2017	58019	2.2
Sept. 13, 2017	58009	1.7
Sept. 3, 2017	57999	0.6
Aug. 24, 2017	57989	1.2
Aug. 14, 2017	57979	3.4
Aug. 4, 2017	57969	2.7
Jul. 25, 2017	57959	1.6
Jul. 15, 2017	57949	0.7
Jul. 5, 2017	57939	0.6
Jun. 25, 2017	57929	1
Jun. 15, 2017	57919	0
Jun. 5, 2017	57909	-1.3

3. BROADCAST OUTAGES OVER FIVE MINUTES AND WWVB PHASE PERTURBATIONS

OUTAGES OF 5 MINUTES OR MORE						PHASE PERTURBATIONS 2 ms			
Station	Apr 2018	MJD	Began UTC	Ended UTC	Freq.	Apr 2018	MJD	Began UTC	End UTC
WWVB	04/06/18	58214	0855	1010	60 kHz	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)
May 18	-37	-457921.95	-37.30*	58241	58270
May 18	-37	-457848.35	-36.8	58239	58241†
Apr 18	-37	-456744.35	-36.8	58209	58239
Mar 18	-37	-456744.35	-36.8	58207	58209
Mar 18	-37	-456114.25	-37.10	58192	58207†
Mar 18	-37	-455635.85	-36.80	58179	58192†
Mar 18	-37	-455599.25	-36.60	58178	58179†
Feb 18	-37	-455086.85	-36.60	58164	58178
Feb 18	-37	-454570.25	-36.90	58150	58164†
Jan 18	-37	-454311.95	-36.90	58143	58150
Jan 18	-37	-453796.75	-36.80	58129	58143†
Jan 18	-37	-453427.25	-36.95	58119	58129†
Dec 17	-37	-453316.4	-36.95	58116	58119
Dec 17	-37	-452765.15	-36.75	58101	58116†
Dec 17	-37	-452284.15	-37.00	58088	58101†
Nov 17	-37	-451988.15	-37	58080	58088
Nov 17	-37	-451215.35	-36.80	58059	58080†
Nov 17	-37	-451178.25	-37.10	58058	58059†
Oct 17	-37	-450695.95	-37.10	58045	58058
Oct 17	-37	-450029.95	-37	58027	58045†
Sep 17	-37	449659.95	-37.00	58017	58027
Sep 17	-37	448915.95	-37.20	57997	58017†
Aug 17	-37	448619.95	-37.1	57989	57997
Aug 17	-37	448360.85	-36.9	57982	57989†
Aug 17	-37	-448101.15	-37.1	57975	57982†
Aug 17	-37	-447765.9	-37.25	57966	57975†
Jul 17	-37	-447058.15	-37.25	57947	57966
Jul 17	-37	-446612.35	-37.15	57935	57947†
Jun 17	-37	-446278	-37.15	57926	57935
Jun 17	-37	-445643.05	-37.35	57909	57926†
Jun 17	-37	-445492.85	-37.55	57905	57909†
May 17	-37	-445230	-37.55	57898	57905
May 17	-37	-444745.75	-37.25	57885	57898†
May 17	-37	-444448.55	-37.15	57877	57885†
May 17	-37	-444338	-36.85	57874	57877†

† Rate change in mid-month

*Provisional value