



**NIST Interagency Report
NIST IR 8529-09**

NIST Time and Frequency Bulletin

Kelsey Rodriguez, Editor

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<https://doi.org/10.6028/NIST.IR.8529-09>

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Physical Measurement Laboratory

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September 2024
No. 801



U.S. Department of Commerce
Gina M. Raimondo, Secretary

National Institute of Standards and Technology
Laurie E. Locascio, NIST Director and Under Secretary of Commerce for Standards and Technology

NIST IR 8529-09
September 2024

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Publication History

Approved by the NIST Editorial Review Board on 2024-06-24.

How to Cite this NIST Technical Series Publication

Rodriguez, K. (2024) NIST Time and Frequency Bulletin. (National Institute of Standards and Technology, Boulder, CO), NIST Interagency Report (IR) NIST IR 8529-09. <https://doi.org/10.6028/NIST.IR.8529-09>

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Abstract

The Time and Frequency Bulletin provides information on performance of time scales and a variety of broadcasts (and related information) to users of the NIST services.

Keywords

Clocks; dissemination; frequency; GPS; oscillators; time.

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1. Time Scale Information

The values listed in the table below are based on data from the IERS, the USNO, and NIST. The UTC(USNO, MC) – UTC(NIST) values are obtained from the BIPM. UTC – UTC(NIST) data are on page 3.

Table 1. Variation in UT1 – UTC(NIST) and UTC(USNO, MC) – UTC(NIST) Time Scales.

0000 HOURS COORDINATED UNIVERSAL TIME			
August 2024	MJD	UT1 – UTC(NIST) (±1 ms)	UTC(USNO, MC) – UTC(NIST) (±5 ns)
2	60524	26.5 ms	1.5 ns
7	60529	32.0 ms	2.0 ns
12	60534	35.7 ms	1.2 ns
17	60539	42.0 ms	-0.5 ns
22	60544	44.5 ms	-0.4 ns
27	60549	46.5 ms	-0.6 ns

The 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 Earth’s period of rotation.

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 insertion 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.

Table 2. Corrections made to DUT1.

DUT1 = UT1 – UTC =	+0.1 s beginning 0000 UTC 05 September 2024
	+0.0 s beginning 0000 UTC 28 July 2022
	-0.1 s beginning 0000 UTC 17 July 2021
	-0.2 s beginning 0000 UTC 02 May 2019
	-0.1 s beginning 0000 UTC 17 January 2019
	+0.0 s beginning 0000 UTC 21 September 2018
	+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

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 recent periods where data are available. Data are given at ten-day intervals. Five-day interval data are available in *Circular T*.

Table 3. UTC – UTC(NIST).

0000 Hours Coordinated Universal Time		
DATE	MJD	UTC-UTC(NIST), ns
August 27, 2024	60549	-1.1
August 17, 2024	60539	-0.1
August 7, 2024	60529	0.6
July 28, 2024	60519	0.2
July 18, 2024	60509	-0.1
July 8, 2024	60499	0.2
June 28, 2024	60489	0.1
June 18, 2024	60479	-0.0
June 8, 2024	60469	-0.2
May 29, 2024	60459	-0.0
May 19, 2024	60449	0.5
May 9, 2024	60439	0.3
Apr. 29, 2024	60429	-0.2
Apr. 19, 2024	60419	-0.1
Apr. 9, 2024	60409	2.0
Mar. 30, 2024	60399	0.0
Mar. 20, 2024	60389	-1.6
Mar. 10, 2024	60379	-0.5
Feb. 29, 2024	60369	-0.7
Feb. 19, 2024	60359	-0.4
Feb. 09, 2024	60349	-1.5
Jan. 30, 2024	60339	-1.7
Jan. 20, 2024	60329	-1.6
Jan. 10, 2024	60319	-2.0
Dec. 31, 2023	60309	-0.8
Dec. 21, 2023	60299	-1.0
Dec. 11, 2023	60289	1.2

2. Broadcast Outages Over Five Minutes and WWVB Phase Perturbations

Table 4. Broadcast Outages and Phase Perturbations.

OUTAGES OF 5 MINUTES OR MORE						PHASE PERTURBATIONS 2 ms			
Station	August 2024	MJD	Began UTC	Ended UTC	Freq.	August 2024	MJD	Began UTC	End UTC
WWVB	12	60534	0101	0145	60 kHz	None			
WWV	None					None			
WWVH	None					None			

3. 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. Cold-atom cesium fountain frequency standards, currently NIST-F3 and NIST-F4, have served as the U.S. primary standards of time and frequency since 1999. The uncertainty of the primary standards is currently 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 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.

UTC(NIST) is generated as an offset from our real-time scale AT1. Time steps are never used. Instead, the frequency is steered so that the time output remains close to UTC. This is accomplished by using data published by the BIPM in its *Circular T* and by weekly estimates of UTC, which are published by the BIPM as rapid UTC or UTCr. Changes in the frequency may be made as often as once per week and are limited to $\pm 2.3 \times 10^{-14}$. The frequency of UTC(NIST) is kept as stable as possible at other times.

4. UTC NIST – AT1 Parameters

Table 5 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.

Table 5. UTC(NIST) - 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)
Aug 24	-37	-544425.02	-38.58†	60544	60551
Aug 24	-37	-543887.00	-38.43†	60530	60544
Aug 24	-37	-543617.29	-38.53	60523	60530
Jul 24	-37	-542419.76	-38.63	60491	60523
Jun 24	-37	-541260.86	-38.63	60462	60491
May 24	-37	-540642.78	-38.63†	60446	60462
May 24	-37	-540062.58	-38.68	60431	60446
Apr 24	-37	-539559.74	-38.68†	60418	60431
Apr 24	-37	-539021.72	-38.43†	60404	60418
Apr 24	-37	-538904.93	-38.98	60401	60404
Mar 24	-37	-538749.21	-38.93†	60397	60401
Mar 24	-37	-538477.40	-38.83†	60390	60397
Mar 24	-37	-537936.58	-38.63†	60376	60390
Mar 24	-37	-537703.90	-38.78	60370	60376
Feb 24	-37	-537122.20	-38.78†	60355	60370
Feb 24	-37	-536849.69	-38.93†	60348	60355
Feb 24	-37	-536578.58	-38.73	60341	60348
Jan 24	-37	-536307.47	-38.73†	60334	60341
Jan 24	-37	-535768.07	-38.53†	60320	60334
Jan 24	-37	-535384.27	-38.38	60310	60320
Dec 23	-37	-534962.09	-38.38†	60299	60310*
Dec 23	-37	-534428.27	-38.13†	60285	60299
Dec 23	-37	-534197.69	-38.43	60279	60285
Nov 23	-37	-533890.25	-38.43†	60271	60279
Nov 23	-37	-533621.59	-38.38†	60264	60271
Nov 23	-37	-533086.37	-38.23†	60250	60264
Nov 23	-37	-533048.29	-38.08	60249	60250
Oct 23	-37	-532553.25	-38.08†	60236	60249
Oct 23	-37	-532285.99	-38.18†	60229	60236
Oct 23	-37	-532018.39	-38.23†	60222	60229
Oct 23	-37	-531864.67	-38.43	60218	60222

† Rate change in mid-month

*Provisional value

References

- [1] Levine, J (2012) The statistical modeling of atomic clocks and the design of time scales. *Review of Scientific Instruments*, 83: 0211101/1-28 (<https://dx.doi.org/10.1063/1.3681448>).
- [2] Parker, T; Jefferts, S; Heavner, T; and Donley, E (2005) Operation of the NIST-F1 caesium fountain primary frequency standard with a maser ensemble, including the impact of frequency transfer noise. *Metrologia* 42: 423-430 (<https://doi.org/10.1088/0026-1394/42/5/013>).
- [3] Sherman, J; Arissian, L; Brown, R; Deutch, M; Donley, E; Gerginov, V; Levine, J; Nelson, G; Novick, A; Patla, B; Parker, T; Stuhl, B; Sutton, D; Yao, J; Yates, W; Zhang, B; and Lombardi, M (2021) A Resilient Architecture for the Realization and Distribution of Coordinated Universal Time to Critical Infrastructure Systems in the United States: Methodologies and Recommendations from the National Institute of Standards and Technology (NIST). NIST Technical Note 2187, 189 p. (<https://doi.org/10.6028/NIST.TN.2187>).

Appendix A. List of Symbols, Abbreviations, and Acronyms

ACTS

Automated Computer Time Service

BIPM

Bureau International des Poids et Mesures

GPS

Global Positioning System

IERS

International Earth Rotation Service

MC

Master Clock

min

minute

MJD

Modified Julian Date

ms

Millisecond

NIST

National Institute of Standards and Technology

ns

Nanosecond

SI

International System of Units

TA

Atomic Time

TAI

International Atomic Time

s

Second

USNO

United States Naval Observatory

UT1

Universal Time (Astronomical)

UTC

Coordinated Universal Time

μs

Microsecond