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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
SI - International System of Units
TA - Atomic Time
TAI - International Atomic Time
USNO - United States Naval Observatory
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			
Jan 2009	MJD	UT1-UTC(NIST) (±5 ms)	UTC(USNO,MC) - UTC(NIST) (±20 ns)
1	54832	407 ms	11 ns
8	54839	399 ms	12 ns
15	54846	392 ms	12 ns
22	54853	387 ms	11 ns
29	54860	385 ms	9 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: A positive leap second was added at the end of December 2008.

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 timescale on 30 June 1972, 1981-1983, 1985, 1992-1994, and 1997, and on 31 December 1972-1979, 1987, 1989, 1990,1995, 1998, and 2005.

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 =
-0.6 s beginning 0000 UTC 20 November 2008
-0.5 s beginning 0000 UTC 07 August 2008
-0.4 s beginning 0000 UTC 13 March 2008
-0.3 s beginning 0000 UTC 29 November 2007

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 10-day intervals. Five-day interval data are available in *Circular T*.

0000 Hours Coordinated Universal Time		
DATE	**MJD**	**UTC-UTC(NIST) ns**
Dec. 29, 2008	54829	4.1
Dec. 19, 2008	54819	2.5
Dec. 09, 2008	54809	0.7
Nov. 29, 2008	54799	0.5
Nov. 19, 2008	54789	-1.0
Nov. 09, 2008	54779	-2.1
Oct. 30, 2008	54769	-3.3
Oct. 20, 2008	54759	-5.7
Oct. 10, 2008	54749	-5.4
Sep. 30, 2008	54739	-4.7
Sep, 20, 2008	54729	-2.0
Sep. 10, 2008	54719	-1.2
Aug. 31, 2008	54709	-1.4
Aug. 21, 2008	54699	0.9
Aug. 11, 2008	54689	1.3
Aug. 01, 2008	54679	3.0
Jul. 22, 2008	54669	3.5
Jul. 12, 2008	54659	4.1
Jul. 02, 2008	54649	3.9
Jun. 22, 2008	54639	1.1
Jun. 12, 2008	54629	-2.0
Jun. 02, 2008	54619	-4.6
May 23, 2008	54609	-7.8
May 13, 2008	54599	-8.4
May 03, 2008	54589	-10.2
Apr. 23, 2008	54579	-10.1
Apr. 13, 2008	54569	-12.8
Apr. 03, 2008	54559	-12.5

3. PHASE DEVIATIONS FOR WWVB AND LORAN-C

WWVB - The values shown for WWVB are the time differences between the time markers of the UTC(NIST) time scale and the first positive-going zero voltage crossover measured at the transmitting antenna. The uncertainty of the individual measurements is ±0.5 μs. The values listed are for 1300 UTC.

LORAN-C - The values shown for LORAN-C represent the daily accumulated phase shift. The phase shift is measured by comparing the output of a LORAN receiver to the UTC(NIST) time scale for a period of 24 h. If data were not recorded on a particular day, the symbol (-) is printed. The stations monitored are Baudette, Minnesota (8970) and Boise City, Oklahoma (9610). The monitoring is done from the NIST laboratories in Boulder, Colorado.

Note: The values shown for LORAN-C are in nanoseconds.

		UTC(NIST)-WWVB (60 kHz)	UTC(NIST) - LORAN PHASE (ns)	
DATE	MJD	ANTENNA PHASE (μs)	LORAN-C (BAUDETTE) (8970)	LORAN-C (BOISE CITY) (9610)
01/01/2009	54832	5.65	-10	-18
01/02/2009	54833	5.65	+12	+10
01/03/2009	54834	5.65	+19	+45
01/04/2009	54835	5.65	+22	+1
01/05/2009	54836	5.65	-9	-4
01/06/2009	54837	5.65	+7	+1
01/07/2009	54838	5.65	-22	-40
01/08/2009	54839	5.65	-7	-9
01/09/2009	54840	5.65	-6	-7
01/10/2009	54841	5.65	+21	+19
01/11/2009	54842	5.65	0	+0
01/12/2009	54843	5.65	+16	+51
01/13/2009	54844	5.65	+24	-38
01/14/2009	54845	5.65	-18	-25
01/15/2009	54846	5.65	-18	-4
01/16/2009	54847	5.65	+73	-14
01/17/2009	54848	5.65	-44	-7
01/18/2009	54849	5.65	+48	+11
01/19/2009	54850	5.65	-100	-11
01/20/2009	54851	5.65	-27	-1
01/21/2009	54852	5.65	-33	+12
01/22/2009	54853	5.65	-26	-16
01/23/2009	54854	5.65	+17	+10
01/24/2009	54855	5.65	+52	+3
01/25/2009	54856	5.65	+19	-11
01/26/2009	54857	5.65	+53	+32
01/27/2009	54858	5.65	-19	+32
01/28/2009	54859	5.65	-66	-26
01/29/2009	54860	5.65	-16	-1
01/30/2009	54861	5.65	+15	-28
01/31/2009	54862	5.65	-43	-10

4. BROADCAST OUTAGES OVER FIVE MINUTES AND WWVB PHASE PERTURBATIONS

OUTAGES OF 5 MINUTES OR MORE						PHASE PERTURBATIONS 2 ms			
Station	Jan 2009	MJD	Began UTC	Ended UTC	Freq.	Jan 2009	MJD	Began UTC	End UTC
WWVB	01-01-09	54832	0504	0615	60 kHz				
WWVB	01-02-09	54833	0317	0351	60 kHz				
WWV									
WWVH									

5. 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 time and frequency standard since 1999. The uncertainty of NIST-F1 is currently about 5 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.

6. BIBLIOGRAPHY

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Table 7.1 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.

Table 7.1

$$UTC(NIST) - AT1 = x_{ls} + x + y*(T - T_0)$$

Month	x_{ls} (s)	x (ns)	y (ns/d)	T_0 (MJD)	Valid until 0000 on: (MJD)
Mar 09	-34	-331693.6	-38.3*	54891	54922
Feb 09	-34	-330621.2	-38.3	54863	54891*
Jan 09	-34	-329931.8	-38.3	54845	54863
Jan 09	-34	-329432.6	-38.4	54832	54845†
Dec 08	-33	-328895.0	-38.4	54818	54832
Dec 08	-33	-328240.5	-38.5	54801	54818†
Nov 08	-33	-327085.5	-38.5	54771	54801
Oct 08	-33	-326392.5	-38.5	54753	54771
Oct 08	-33	-325894.6	-38.3*	54740	54753†
Sep 08	-33	-324745.6	-38.3	54710	54740
Aug 08	-33	-323558.3	-38.3	54679	54710
Jul 08	-33	-322792.3	-38.3	54659	54679
Jul 08	-33	-322369.9	-38.4	54648	54659†
Jun 08	-33	-321211.9	-38.6	54618	54648
May 08	-33	-320594.3	-38.6	54602	54618
May 08	-33	-320018.3	-38.4	54587	54602†
Apr 08	-33	-319288.7	-38.4	54568	54587
Apr 08	-33	-318867.4	-38.3	54557	54568†
Mar 08	-33	-318178.0	-38.3	54539	54557
Mar 08	-33	-317684.0	-38.0	54526	54539†
Feb 08	-33	-316582.0	-38.0	54497	54526
Jan 08	-33	-315974.0	-38.0	54481	54497
Jan 08	-33	-315405.5	-37.9	54466	54481†

† Rate change in mid-month
***Provisional value**