NIST TIME AND FREQUENCY BULLETIN
NISTIR 5057-12

NO. 481 DECEMBER 1997

This bulletin is published monthly. Address correspondence to:

Gwen E. Bennett, Editor
Time and Frequency Division
National Institute of Standards and Technology
325 Broadway
Boulder, CO 80303-3328
(303) 497-3295

NOTE TO SUBSCRIBERS: Please include your address label (or a copy) with any correspondence regarding this bulletin.

U.S. DEPARTMENT OF COMMERCE, William M. Daley, Secretary
TECHNOLOGY ADMINISTRATION, Mary L. Good, Under Secretary for Technology
NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY, Robert Hebner, Acting Deputy Director

1. GENERAL BACKGROUND INFORMATION

ABBREVIATIONS AND ACRONYMS USED IN THIS BULLETIN

BIPM	- Bureau International des Poids et Mesures				
CCIR	- International Radio Consultative Committee				
cs	Cesium standard				
GOES	- Geostationary Operational Environmental Satellite				
GPS	Global Positioning System				
IERS	- International Earth Rotation Service				
LORAN	- Long Range Navigation				
MC	Master Clock				
MJD	- Modified Julian Date				
NVLAP	- National Voluntary Laboratory Accreditation Program				
NIST	- National Institute of Standards & Technology				
NOAA	- National Oceanic and Atmospheric Administration	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				
VLF	very low frequency				

2. TIME SCALE INFORMATION

NOV 1997	MJD	UT1 −UTC(NIST)	UTC(USNO,MC) − UTC(NIST)
6	50758	+317 ms	5 ns
13	50765	+299 ms	3 ns
20	50772	+287 ms	3 ns
27	50779	+275 ms	5 ns

3. UT1 CORRECTIONS AND LEAP SECOND ADJUSTMENTS

The master clock pulses used by the WWV, WWVH, WWVB, and GOES 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 rotation of the Earth.

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, 1993, 1994, and 1997, and on 31 December 1972-1979,1987, 1989, 1990, and 1995.

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 DUTI correction. DUTI corrections are broadcast by WWV, WWVH, WWVB, and GOES and are printed below. These corrections may be added to received UTC time signals in order to obtain UT1.

DUTI = UT1 - UTC =
+0.4 s beginning 0000 UTC 18 September 1997
+0.3 s beginning 0000 UTC 30 October 1997
+0.2 s beginning 0000 UTC 18 December 1997

4. PHASE DEVIATIONS FOR WWVB AND LORAN-C

WWVB - The values shown for WWVB are the time difference 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 (in ns). 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 master stations monitored are Dana, IN (8970) and Fallon, NV (9940). The monitoring is done from the NIST laboratories in Boulder, CO.

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 (DANA) (8970)	LORAN-C (FALLON)' (9940)
11/01/97	50753	5.74	+361	+116
11/02/97	50754	5.73	+114	-32
11/03/97	50755	5.73	-400	-215
11104197	50756	5.71	+84	-157
11/05/97	50757	5.75	-105	-216
11/06/97	50758	5.75	- 5	+366
11/07/97	50759	5.75	+58	+155
11108197	50760	5.75	-377	+1
11109197	50761	5.77	+445	-300
11/10/97	50762	5.77	-159	+80
11/11/97	50763	5.78	-263	-112
11/12/97	50764	5.73	-178	-244
11/13/97	50765	5.77	-440	+320
11/14/97	50766	5.66	-160	-118
11/15/97	50767	5.76	+121	+32
11/16/97	50768	5.76	-107	-200
11/17/97	50769	5.83	+228	+269
11/18/97	50770	5.75	-669	+207
11/19/97	50771	5.74	+131	+148
11120197	50772	5.65	+9	-17
11/21/97	50773	5.65	+123	+65
11/22/97	50774	5.66	+403	+205
11123197	50775	5.67	-126	-194
11/24/97	50776	5.68	-72	-323
11/25/97	50777	5.69	-141	+218
11126197	50778	5.68	-158	+258
11127197	50779	5.68	-92	-220
11/28/97	50780	5.71	+62	-110
11/29/97	50781	5.71	+5	-286
11/30/97	50782	5.71	-92	+126

4. PHASE DEVIATIONS FOR WWVB AND LORAN-C

WWVB - The values shown for WWVB are the time difference 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 (in ns). 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 master stations monitored are Dana, IN (8970) and Fallon, NV (9940). The monitoring is done from the NIST laboratories in Boulder, CO.

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 (DANA) (8970)	LORAN-C (FALLON)' (9940)
11/01/97	50753	5.74	+361	+116
11102197	50754	5.73	+114	-32
11/03/97	50755	5.73	-400	-215
11104197	50756	5.71	+84	-157
11/05/97	50757	5.75	-105	-216
11/06/97	50758	5.75	-5	+366
11107197	50759	5.75	+58	+155
11108197	50760	5.75	-377	+1
11109197	50761	5.77	+445	-300
11/10/97	50762	5.77	-159	+80
11/11/97	50763	5.78	-263	-112
11/12/97	50764	5.73	-178	-244
11/13/97	50765	5.77	-440	+320
11/14/97	50766	5.66	-160	-118
11/15/97	50767	5.76	+121	+32
11/16/97	50768	5.76	-107	-200
11/17/97	50769	5.83	+228	+269
11/18/97	50770	5.75	-669	+207
11/19/97	50771	5.74	+131	+148
11120197	50772	5.65	+9	-17
11/21/97	50773	5.65	+123	+65
11/22/97	50774	5.66	+403	+205
11/23/97	50775	5.67	-126	-194
11/24/97	50776	5.68	-72	-323
11/25/97	50777	5.69	-141	+218
11/26/97	50778	5.68	-158	+258
11127197	50779	5.68	-92	-220
11128197	50780	5.71	+62	-110
11/29/97	50781	5.71	+5	-286
11130197	50782	5.71	-92	+126

5. GOES TIME CODE INFORMATION

A. TIME CODE PERFORMANCE (1-31 November 1997)

GOES/East:

Currently using the GOES-8 satellite at 75° west longitude. Timing uncertainty is ±100 μs with respect to UTC(NIST).

GOES/West:

Currently using the GOES-9 satellite at 135° west longitude. Timing uncertainty is ±100 μs with respect to UTC(NIST).

NOTE: The next anticipated WWVB service interruptions will be in December 1997. This interruption is needed to test the WWVB transmitters on the antenna system. The exact dates, start times, and durations will be posted at **http://www.bldrdoc.gov/timefreq/vboutage.htrn** when the information becomes available.

6. BROADCAST OUTAGES OVER 5 MINUTES AND WWVB PHASE PERTURBATIONS

Station	NOV 1997	MJD	Began UTC	Ended UTC	Freq.		NOV 1997	MJD	Began UTC	End UTC
WWVB	11/6	50758	1700	1900	60 kHz					
WWV										
WWVH										

10^{14}.

Table **7.1** is a list of the 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 offset in time and in 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.

Month	x_{ls} (s)	x (ns)	y (ns/day)	T_0 (MJD)	Valid until 0000 on: (MJD)
Feb 96	−30	−140035	−43.5	50114	50143
Mar 96	−30	−141297	−43.5	50143	50174
Apr 96	−30	−142645	−43.5	50174	50204
May 96	−30	−143950	−43.5	50204	50235
Jun 96	−30	−145299	−43.5	50235	50265
Jul 96	−30	−146604	-44.0	50265	50296
Aug 96	−30	−147968	-44.5	50296	50327
Sep 96	−30	−149347	-44.5	50327	50357
Oct 96	−30	−150682	-44.0	50357	50388
Nov 96	−30	−152046	-44.0	50388	50418
Dec 96†	−30 −30	−153366 −154066.8	-43.8 -42.6	50418 50434	50434 50449
Jan 97	−30	−154705.8	-42.5	50449	50480
Feb 97	−30	−156023.3	-42.5	50480	50508
Mar 97	−30	−157213.3	-42.7	50508	50539
Apr 97	−30	−158537	-42.5	50539	50569
May 97	−30	−159812	-43.0	50569	50600
Jun 97	−30	-161145	−43.0	50600	50630
Jul 97	-31	−162435	-43.0	50630	50661
Aug 97	-31	−163768	-43.0	50661	50692
Sep 97	-31	−165101	-42.5	50692	50722
Oct 97	-31	−166376	-42.0	50722	50753
Nov 97	-31	−167678	-42.0	50753	50783
Dec 97	-31	−168938	-42.5	50783	50814
Jan 98	−31	−170255	-42.5"	50814	50845

†**Note** rate change in mid-month

9. SPECIAL ANNOUNCEMENTS

TRACEABLE FREQUENCY CALIBRATIONS
(Now NVLAP Certified)

Anyone needing traceable frequency calibrations can get them by subscribing to the NIST Frequency Measurement and Analysis Service. This service is offered on a lease basis by NIST to provide an easy and inexpensive means to obtain traceability of a laboratory main oscillator and, in addition, to calibrate other devices in the lab. This service has been designed for ease of operation and as a practical lab calibration tool.

All the equipment and software needed are provided by NIST. Users must provide their own oscillator(s) and an ordinary telephone line so that NIST can access the system by modem. A total of four oscillators can be calibrated at the same time. Radio signals from either Loran-C or GPS satellite are used. Results for either are at about the same accuracy.

The calibration data are displayed in color and a graph is plotted daily for each oscillator connected. Data are also stored on disk. The user can call up any of the data and view them onscreen or in the form of plots. Many months of data can be plotted.

The system plots are easy to read and understand. The system manual is written for easy understanding and the NIST staff is available by telephone to assist. The modem connection allows NIST to access the data and to prepare a monthly traceability report which is mailed to the user.

Frequency sources of any accuracy can be calibrated. The FMAS is particularly useful at the highest levels of performance. This is because each user of the system contributes information and calibration data for the others. If an uncertainty arises, it is possible for NIST to call by modem to another user nearby. In this way problems in data interpretation can be resolved.

NVLAP certification requirements for frequency measurement are met by following the NIST-FMAS operating manual. This service does not eliminate the NVLAP audits but, when installed and operated per the NIST guidelines, audit requirements are easily met.

NIST retains title to the equipment and supplies any needed system spares. Equipment that fails is replaced by overnight shipment. Training for use of the system is available if requested by the user.

The NIST Frequency Measurement and Analysis Service provides a complete solution to nearly all frequency measurement and calibration problems. For a free information package, please call Michael Lombardi at (303) 497-3212, or write to: Michael Lombardi, NIST, Division 847, 325 Broadway, Boulder, CO 80303.
