



Concern on UTC Leap Second Schedule Announcements

Karl Kovach

15 Aug 19

UTC & Leap Seconds



- **International Earth Rotation Service (IERS)**
 - *The “keeper” of UTC*
 - The ‘decider’ of UTC leap seconds
- **U.S. Naval Observatory (USNO)**
 - *Contributes to IERS for UTC*
 - Follows IERS for UTC leap seconds
- **U.S. Department of Defense (DoD)**
 - *Follows USNO for UTC & UTC leap seconds*
- **Global Positioning System (GPS)**
 - *Should be following USNO for UTC & UTC leap seconds*

UTC Leap Second Announcements



- **IERS announces the UTC leap second schedule**
 - *USNO forwards the IERS announcements*
 - DoD uses the IERS leap second announcements
 - *GPS should simply follow along...*

IERS “Bulletin C” Announcements



INTERNATIONAL EARTH ROTATION AND REFERENCE SYSTEMS SERVICE (IERS)
SERVICE INTERNATIONAL DE LA ROTATION TERRESTRE ET DES SYSTEMES DE REFERENCE
SERVICE DE LA ROTATION TERRESTRE DE L'IERS
OBSERVATOIRE DE PARIS
61, Av. de l'Observatoire 75014 PARIS (France)
Tel. : +33 1 40 51 23 35
e-mail : services.iers@obspm.fr
<http://hpiers.obspm.fr/eop-pc>

Paris, 6 July 2016

Bulletin C 52

To authorities responsible for the measurement and distribution of time

UTC TIME STEP
on the 1st of January 2017

A positive leap second will be introduced at the end of December 2016.
The sequence of dates of the UTC second markers will be:

2016 December 31, 23h 59m 59s
2016 December 31, 23h 59m 60s
2017 January 1, 0h 0m 0s

The difference between UTC and the International Atomic Time TAI is:

from 2015 July 1, 0h UTC, to 2017 January 1 0h UTC : UTC-TAI = - 36s
from 2017 January 1, 0h UTC, until further notice : UTC-TAI = - 37s

Leap seconds can be introduced in UTC at the end of the months of December or June, depending on the evolution of UT1-TAI. Bulletin C is mailed every six months, either to announce a time step in UTC or to confirm that there will be no time step at the next possible date.

Christian Bizouard
Head
Earth Orientation Center of IERS
Observatoire de Paris, France

Paris, 6 July 2016 – Bulletin C 52

IERS “Bulletin C” Announcements



INTERNATIONAL EARTH ROTATION AND REFERENCE SYSTEMS SERVICE (IERS)
SERVICE INTERNATIONAL DE LA ROTATION TERRESTRE ET DES SYSTEMES DE REFERENCE

SERVICE DE LA ROTATION TERRESTRE
OBSERVATOIRE DE PARIS
61, Av. de l'Observatoire 75014 PARIS (France)
Tel. : 33 (0) 1 40 51 23 35
FAX : 33 (0) 1 40 51 22 91
Internet : services.iers@obspm.fr

Paris, 9 January 2017

Bulletin C 53

To authorities responsible
for the measurement and
distribution of time

INFORMATION ON UTC - TAI

NO leap second will be introduced at the end of June 2017.
The difference between Coordinated Universal Time UTC and the
International Atomic Time TAI is :

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Christian BIZOUARD
Director
Earth Orientation Center of IERS
Observatoire de Paris, France

Paris, 9 January 2017 – Bulletin C 53

IERS "Bulletin C" Announcements



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Paris, 06 July 2017

Bulletin C 54

To authorities responsible
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INFORMATION ON UTC - TAI

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Christian BIZOUARD
Director
Earth Orientation Center of IERS
Observatoire de Paris, France

Paris, 06 July 2017 – Bulletin C 54

IERS "Bulletin C" Announcements



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61, Av. de l'Observatoire 75014 PARIS (France)
Tel. : +33 1 40 51 23 35
e-mail : services.iers@obspm.fr
<http://hpiers.obspm.fr/eop-pc>

Paris, 09 January 2018

Bulletin C 55

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Christian BIZOUARD
Director
Earth Orientation Center of IERS
Observatoire de Paris, France

Paris, 09 January 2018 – Bulletin C 55

IERS "Bulletin C" Announcements



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61, Av. de l'Observatoire 75014 PARIS (France)
Tel. : +33 1 40 51 23 35
e-mail : services.iers@obspm.fr
<http://hpiers.obspm.fr/eop-pc>

Paris, 05 July 2018

Bulletin C 56

To authorities responsible
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Christian BIZOUARD
Director
Earth Orientation Center of IERS
Observatoire de Paris, France

Paris, 05 July 2018 – Bulletin C 56

IERS "Bulletin C" Announcements



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OBSERVATOIRE DE PARIS
61, Av. de l'Observatoire 75014 PARIS (France)
Tel. : +33 1 40 51 23 35
e-mail : services.iers@obspm.fr
<http://hpiers.obspm.fr/eop-pc>

Paris, 07 January 2019

Bulletin C 57

To authorities responsible
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Christian BIZOUARD
Director
Earth Orientation Center of IERS
Observatoire de Paris, France

Paris, 07 January 2019 – Bulletin C 57

IERS “Bulletin C” Announcements



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e-mail : services.iers@obspm.fr
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Paris, 04 July 2019

Bulletin C 58

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Christian BIZOUARD
Director
Earth Orientation Center of IERS
Observatoire de Paris, France

Paris, 04 July 2019 – Bulletin C 58

UTC Leap Second Announcements



- **IERS announces the UTC leap second schedule**
 - *USNO forwards the IERS announcements*
 - DoD uses the IERS leap second announcements
 - *GPS should simply follow along...*
- **GPS also announces a UTC leap second schedule**
 - *Should be the same schedule as IERS & USNO*

GPS Leap Second Announcement



IS-GPS-200J
22 May 2018

Table 20-IX. UTC Parameters

Parameter	No. of Bits**	Scale Factor (LSB)	Valid Range***	Units	
A_0	32*	2^{-30}	0 to 602,112	seconds	
A_1	24*	2^{-50}		sec/sec	
Δt_{LS}	8*	1		seconds	
t_{ot}	8	2^{12}		seconds	
WN_t	8	1		weeks	
WN_{LSF}	8	1		weeks	
DN	8	1		1 to 7	days
Δt_{LSF}	8*	1		seconds	
<p>* Parameters so indicated shall be two's complement with the sign bit (+ or -) occupying the MSB;</p> <p>** See Figure 20-1 for complete bit allocation in subframe;</p> <p>*** Unless otherwise indicated in this column, valid range is the maximum range attainable with indicated bit allocation and scale factor.</p>					

GPS Leap Second Announcement



IS-GPS-200J
22 May 2018

Table 20-IX. UTC Parameters

Parameter	No. of Bits**	Scale Factor (LSB)	Valid Range***	Units
A ₀	32*	2 ⁻³⁰		seconds
A ₁	24*	2 ⁻⁵⁰		sec/sec
Δt_{LS}	8*	1		seconds
t _{ot}	8	2 ¹²	0 to 602,112	seconds
WN _t	8	1		weeks
WN _{LSF}	8	1		weeks
DN	8	1	1 to 7	days
Δt_{LSF}	8*	1		seconds

* Parameters so indicated shall be two's complement with the sign bit (+ or -) occupying the MSB;

** See Figure 20-1 for complete bit allocation in subframe;

*** Unless otherwise indicated in this column, valid range is the maximum range attainable with indicated bit allocation and scale factor.

Leap second offset is now

At the end of this day, leap second offset will be

GPS Leap Second Announcement



IS-GPS-200J
22 May 2018

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** See Figure 20-1 for complete bit allocation in subframe;

*** Unless otherwise indicated in this column, valid range is the maximum range attainable with indicated bit allocation and scale factor.

Leap second offset is now

At the end of this day, leap second offset will be

If no leap second introduced, these two numbers will be the same

UTC Leap Second Announcements



- **IERS announces the UTC leap second schedule**
 - *USNO forwards the IERS announcements*
 - DoD uses the IERS leap second announcements
 - *GPS should simply follow along...*
- **GPS also announces a UTC leap second schedule**
 - *Should be the same schedule as IERS & USNO*
- **We have a major disconnect!**
 - *IERS & USNO have announced:*
 - At end of **31 Dec 19**, no change in leap seconds
 - *GPS currently announcing:*
 - At end of **27 Nov 21**, no change in leap seconds

Impact of Non-Standard Announcement



Menu

IG Inside GNSS Global Navigation Satellite Systems Engineering, Policy, and Design
[\(https://insidengnss.com/\)](https://insidengnss.com/)

U.S. Flights Canceled as FAA Looks into GPS, ADS-B System Errors

June 10, 2019 (<https://insidengnss.com/u-s-flights-canceled-as-faa-looks-into-gps-ads-b-system-errors/>)
 By Stan Goff (<https://insidengnss.com/Author/Stan/>)



<https://insidengnss.com/wp-content/uploads/2019/06/ashim-d-silva-95249-unsplash.jpg>

Passengers stranded at airports is not an uncommon occurrence, but when weather does not appear to be an issue, anxious travelers can get restless searching for answers.

Over the last day or two, a number of U.S. flights were canceled as aircraft were grounded and passengers were left scratching their heads.

<https://insidengnss.com/u-s-flights-canceled-as-faa-looks-into-gps-ads-b-system-errors/> 6/11

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News & Videos Collins Aerospace seeks fix for GPS reception problem

COLLINS AEROSPACE SEEKS FIX FOR GPS RECEPTION PROBLEM

June 14, 2019 | By Dan Narnowitz

Collins Aerospace says a software problem that caused a loss of GPS in some avionics systems the week of June 9 "will no longer occur" beginning June 16 at midnight universal coordinated time (UTC), but "further action" will be needed to put locked systems back in service.

The company issued a status update to its business-aircraft and airline customers on the problem identified in avionics systems using its GPS-4000S (P/N 822-2189-100) and GLU-2100 multi-mode receiver (P/N 822-2532-100).

"Our team has determined the cause and confirmed that a software calculation of UTC time for the week of June 9, 2019 to June 15, 2019 causes a reset condition, resulting in loss of the GPS function. This condition will no longer occur as the GPS constellation transitions into a new week on June 16, 2019 at 0:00 UTC," it said.

AVIONICS

Collins GPS & ADS-B Receivers Struck By Failure Modes

An update to a block of GPS satellites may have caused the widespread failure.

By Julie Boettner
June 11, 2019



The image shows an avionics display with several error messages. On the left, it lists: 'PFD Compare Fail', 'XPDR 1 ADS-B Fail', 'PFD 2 Rel Terr', 'MFD Rel Terr', and 'PFD 1 Rel Terr'. In the center, there's a weather radar display. On the right, a 'Messages' window is open, showing two columns of messages for FMS1 and FMS2. The messages include: 'New Messages', 'None', 'Old Messages', 'GNSS Not Available', 'Check Nav DB Dates', and 'Invalid SBAS Config'.

NBAA Actively Engaged With FAA and Collins Aerospace to Resolve GPS Receiver Disruption



Updated June 17, 2019

<https://nbaa.org/aircraft-operations/communications/navigation-surveillance-cns/global-co...> 6/17/2019

Recommendation



- **Add a requirement clarification to the ISs**
 - *Reword existing requirements for UTC parameters*
 - For example, consider paragraph 20.3.3.5.1.6 of IS-GPS-200J

Is Now:

The UTC parameters shall be updated by the CS at least once every six days while the CS is able to upload the SVs. If the CS is unable to upload the SVs, the accuracy of the UTC parameters transmitted by the SVs will degrade over time.

Should Become:

The UTC parameters [and notices to the user regarding scheduled future or recent past \$\Delta t_{LSF}\$, \$WN_{LSF}\$, and DN values](#) shall be updated/[refreshed](#) by the CS [to be consistent with the UTC and leap second information disseminated by USNO](#) at least once every six days while the CS is able to upload the SVs. If the CS is unable to upload the SVs, the accuracy of the UTC parameters [and the reliability of the leap second information](#) transmitted by the SVs will degrade over time.