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Subject: Recommendation ITU-R TF.460

United States of America

PROPOSED REVISED RECOMMENDATION ITU-R TF.460-6*

Standard-frequency and time signal emissions

(Question ITU-R 102/7)

(1970-1974-1978-1982-1986-1997-2002)

The ITU Radiocommunication Assembly,

considering

- a) that the World Administrative Radio Conference, Geneva, 1979, allocated the frequencies 20 kHz \pm 0.05 kHz, 2.5 MHz \pm 5 kHz (2.5 MHz \pm 2 kHz in Region 1), 5 MHz \pm 5 kHz, 10 MHz \pm 5 kHz, 15 MHz \pm 10 kHz, 20 MHz \pm 10 kHz and 25 MHz \pm 10 kHz to the standard-frequency and time-signal service;
- b) that additional standard frequencies and time signals are emitted in other frequency bands;
- c) the provisions of Article 26 of the Radio Regulations;
- d) the continuing need for close cooperation between Radiocommunication Study Group 7 and the International Maritime Organization (IMO), the International Civil Aviation Organization (ICAO), the General Conference of Weights and Measures (CGPM), the Bureau International des Poids et Mesures (BIPM), the International Earth rotation and Reference system Rotation Service (IERS) and the concerned Unions of the International Council of Scientific Unions (ICSU);
- e) the desirability of maintaining worldwide coordination of standard-frequency and time-signal emissions;
- f) the need to disseminate standard frequencies and time signals in conformity with the second as defined by the 13th General Conference of Weights and Measures (1967);
- g) the desirability of maintaining a relationship between a uniform time scale (UTC) and the time defined by the rotation of the Earth (UT1); the continuing need to make universal time (UT) immediately available to an uncertainty of one-tenth of a second;

* This Recommendation should be brought to the attention of the IMO, the ICAO, the CGPM, the BIPM, the IERS, the International Union of Geodesy and Geophysics (IUGG), the International Union of Radio Science (URSI) and the International Astronomical Union (IAU).

h) that the complexity of the variability of the Earth's rotation currently limits the accuracy with which the difference between the two types of time scales can be predicted to a few tenths of a second one year in advance;

i) that the International Earth rotation and Reference system Service (IERS) provides updated data relating the two time scales daily to users;

recommends

1 that all standard-frequency and time-signal emissions conform as closely as possible to coordinated universal time (UTC) (as defined in the see Annex 4); that the ~~transmission transition of~~ the time signals should not deviate from UTC by more than 1 microsecond ms; that ~~the~~ standard frequencies should not deviate by more than 1 part in 10^{11+0} , and that the time signals emitted from each transmitting station should bear a known relation to the phase of the carrier;

2 that the IERS provide convenient access to values of $UT1-UTC$ so that users have access to $UT1$; ~~standard-frequency and time-signal emissions, and other time-signal emissions intended for scientific applications (with the possible exception of those dedicated to special systems) should contain information on $UT1=UTC$ and $TAI=UTC$ (see Annex 1);~~

3 that, if necessary, adjustments in the epoch of UTC be made following the guidance given in the Annex.

ANNEX 1

Time scales

A Universal time (UT1)

UT1 is the time scale determined from astronomical observations of the rotation of the Earth with respect to the International Celestial Reference System. A technical description and the concepts involved are available in the publications of the IERS (Frankfurt am Main, Germany).

~~Universal time (UT) is the general designation of time scales based on the rotation of the Earth.~~

~~In applications in which an imprecision of a few hundredths of a second cannot be tolerated, it is necessary to specify the form of UT which should be used:~~

~~UT0 — is the mean solar time of the prime meridian obtained from direct astronomical observation;~~

~~UT1 — is UT0 corrected for the effects of small movements of the Earth relative to the axis of rotation (polar variation);~~

~~UT2 — is UT1 corrected for the effects of a small seasonal fluctuation in the rate of rotation of the Earth;~~

~~UT1 — is used in this Recommendation, since it corresponds directly with the angular position of the Earth around its axis of diurnal rotation.~~

~~Concise definitions of the above terms and the concepts involved are available in the publications of the IERS (Paris, France).~~

B International atomic time (TAI)

The international reference scale of atomic time (TAI), based on the second (SI), as realized on the rotating geoid, is formed by the BIPM on the basis of clock data supplied by cooperating establishments. It is in the form of a continuous scale, e.g. in days, hours, minutes and seconds from the origin 1 January 1958 (adopted by the CGPM 1971).

C Coordinated universal time (UTC)

UTC is the time-scale maintained by the BIPM, with assistance from the IERS, which forms the basis of a coordinated dissemination of standard frequencies and time signals. It corresponds exactly in rate with TAI but differs from it by an integer number of seconds. The UTC time scale is in approximate agreement with UT1. The value of the difference UT1-UTC, either observed or predicted, is disseminated by the IERS. It may be regarded as a correction to be added to UTC to obtain UT1.

~~The UTC scale is adjusted by the insertion or deletion of seconds (positive or negative leap-seconds) to ensure approximate agreement with UT1.~~

~~D ——— DUT1~~

Operational Rules
(prior to 0000 UTC, December 21, 2007)

DUT1

The value of the predicted difference $UT1 - UTC$, as disseminated with the time signals is denoted DUT1; thus $DUT1 \approx UT1 - UTC$. DUT1 may be regarded as a correction to be added to UTC to obtain a better approximation to UT1.

The values of DUT1 are given by the IERS in multiples of 0.1 s.

~~The following operational rules apply:~~

1 Tolerances

~~1~~

~~1.1~~ The magnitude of DUT1 should not exceed 0.8 s.

~~1.2~~ The departure of UTC from UT1 should not exceed ± 0.9 s (see Note 1).

~~1.3~~ The deviation of (UTC plus DUT1) should not exceed ± 0.1 s.

NOTE 1 – The difference between the maximum value of DUT1 and the maximum departure of UTC from UT1 represents the allowable deviation of (UTC + DUT1) from UT1 and is a safeguard for the IERS against unpredictable changes in the rate of rotation of the Earth.

2 Leap-seconds

2.1 A positive or negative leap-second should be the last second of a UTC month, but first preference should be given to the end of December and June, and second preference to the end of March and September.

2.2 A positive leap-second begins at 23h 59m 60s and ends at 0h 0m 0s of the first day of the following month. In the case of a negative leap-second, 23h 59m 58s will be followed one second later by 0h 0m 0s of the first day of the following month (see Annex ~~3~~).

2.3 The IERS should decide upon and announce the introduction of a leap-second, such an announcement to be made at least eight weeks in advance.

3 Value of DUT1

3.1 The IERS is requested to decide upon the value of DUT1 and its date of introduction and to circulate this information one month in advance. In exceptional cases of sudden change in the rate of rotation of the Earth, the IERS may issue a correction not later than two weeks in advance of the date of its introduction.

3.2 Administrations and organizations should use the IERS value of DUT1 for standard-frequency and time-signal emissions, and are requested to circulate the information as widely as possible in periodicals, bulletins, etc.

3.3 Where DUT1 is disseminated by code, the code should be in accordance with the following principles (except § 3.4 below):

- the magnitude of DUT1 is specified by the number of emphasized second markers and the sign of DUT1 is specified by the position of the emphasized second markers with respect to the minute marker. The absence of emphasized markers indicates $DUT1 = 0$;
- the coded information should be emitted after each identified minute if this is compatible with the format of the emission. Alternatively the coded information should be emitted, as an absolute minimum, after each of the first five identified minutes in each hour.

Full details of the code are given in [the Annex 2](#).

3.4 DUT1 information primarily designed for, and used with, automatic decoding equipment may follow a different code but should be emitted after each identified minute if this is compatible with the format of the emission. Alternatively, the coded information should be emitted, as an absolute minimum, after each of the first five identified minutes in each hour.

3.5 Other information which may be emitted in that part of the time-signal emission designated in § 3.3 and 3.4 for coded information on DUT1 should be of a sufficiently different format that it will not be confused with DUT1.

3.6 In addition, $UT1 - UTC$ may be given to the same or higher precision by other means, for example, by messages associated with maritime bulletins, weather forecasts, etc.; announcements of forthcoming leap-seconds may also be made by these methods.

3.7 The IERS is requested to continue to publish, in arrears, definitive values of the differences $UT1 - UTC$ and $UT2 - UTC$.

~~E — DTAI~~

~~The value of the difference $TAI - UTC$, as disseminated with time signals, shall be denoted DTAI. $DTAI = TAI - UTC$ may be regarded as a correction to be added to UTC to obtain TAI.~~

~~The $TAI - UTC$ values are published in the BIPM Circular T. The IERS should announce the value of DTAI in integer multiples of one second in the same announcement as the introduction of a leap-second (see § D.2).~~

~~ANNEX 2~~

Code for the transmission of DUT1

A positive value of DUT1 will be indicated by emphasizing a number, n , of consecutive second markers following the minute marker from second marker one to second marker, n , inclusive; n being an integer from 1 to 8 inclusive.

$$DUT1 = (n \times 0.1) \text{ s}$$

A negative value of DUT1 will be indicated by emphasizing a number, m , of consecutive second markers following the minute marker from second marker nine to second marker $(8 + m)$ inclusive, m being an integer from 1 to 8 inclusive.

$$DUT1 = -(m \times 0.1) \text{ s}$$

A zero value of DUT1 will be indicated by the absence of emphasized second markers.

The appropriate second markers may be emphasized, for example, by lengthening, doubling, splitting or tone modulation of the normal second markers.

Examples:

FIGURE 1
DUT1 = + 0.5 s

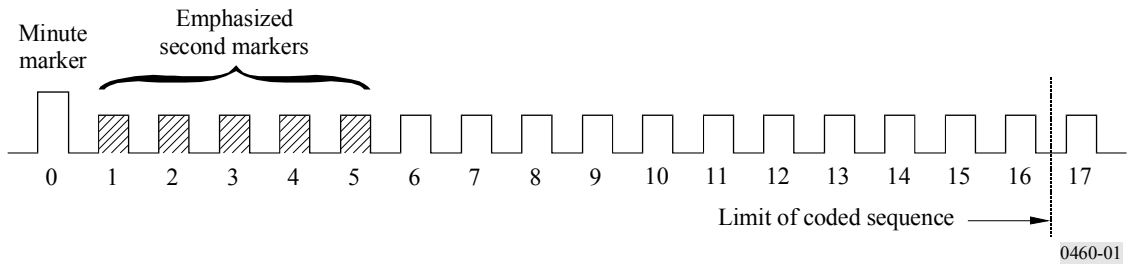
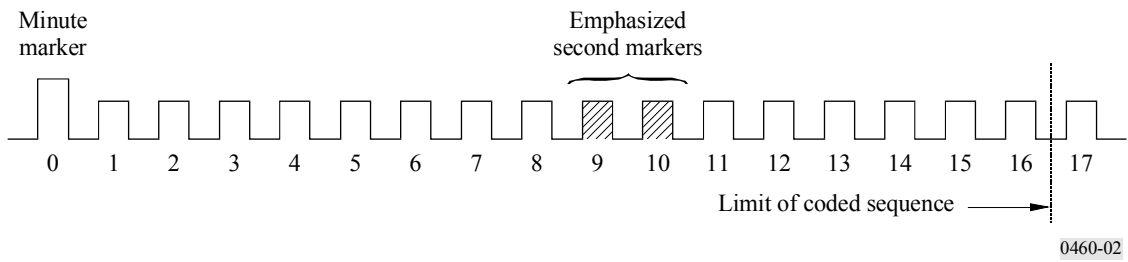


FIGURE 2
DUT1 = - 0.2 s



~~ANNEX 3~~

Dating of events in the vicinity of a leap-second

The dating of events in the vicinity of a leap-second shall be effected in the manner indicated in the following Figures:

FIGURE 3
Positive leap-second

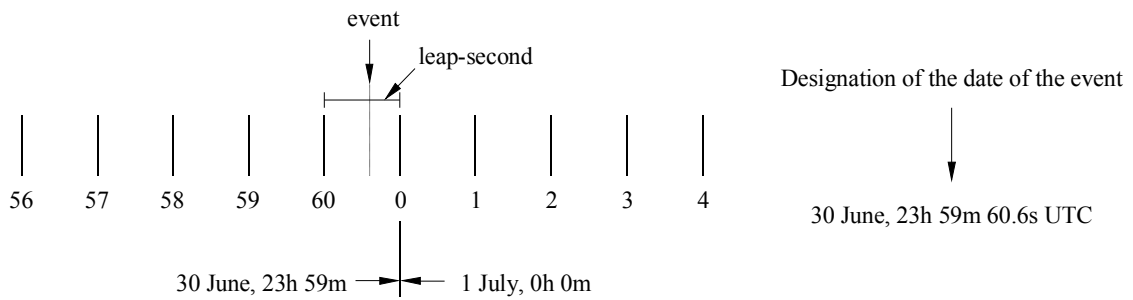
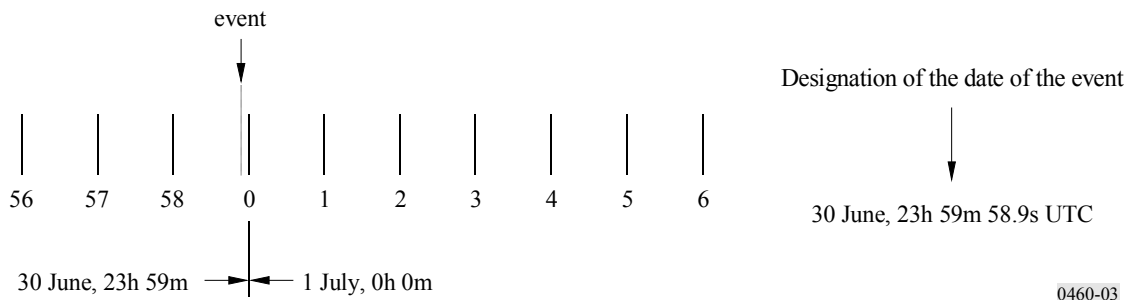


FIGURE 4
Negative leap-second



Operational Rules
(after 0000 UTC December 21, 2007)

1 Tolerance

The difference of UT1 from UTC should not exceed ± 1 h.

2 Adjustments to UTC

2.1 Adjustments to the UTC time scale should be made as determined by the IERS to ensure that the time scale remains within the specified tolerances.

2.2 The IERS should announce the introduction of an adjustment to the UTC time scale as least five years in advance. At the time of the announcement the IERS should provide directions regarding the details of the implementation of the adjustment.

2.3 All operational rules and nomenclature prior to 0000 UTC December 21, 2007 given above no longer apply.

Notes:

(1) The broadcast of DUT1 will be discontinued.

(2) Analysis of historical observations of the Earth's rotation currently indicates that such an adjustment would not be required for at least 500 years.
