

## BUREAU INTERNATIONAL DES POIDS ET MESURES

Circular T 123 (1998 April 9)  
Circulaire T 1231 - Coordinated Universal Time UTC. Computed values of  $UTC - UTC(k)$ .(From 1997 July 1, 0h UTC,  $TAI - UTC = 31$  s)

| Date 1998                     | 0h UTC | Feb 25                                  | Mar 2 | Mar 7 | Mar 12 |
|-------------------------------|--------|---|-------|-------|--------|
|                               | MJD    | 50869                                   | 50874 | 50879 | 50884  |
| Laboratory k                  |        | $UTC - UTC(k)$ (Unit is one nanosecond) |       |       |        |
| AOS (Borowiec)                |        | -375                                    | -418  | -418  | -398   |
| APL (Laurel)                  |        | 5383                                    | 5433  | 5476  | 5526   |
| AUS (Canberra)                |        | 285                                     | 291   | 291   | 311    |
| BIRM (Beijing)                |        | -8754                                   | -8794 | -8793 | -8918  |
| CAO (Cagliari)                |        | -2321                                   | -2338 | -2362 | -2382  |
| CH (Bern)                     |        | 83                                      | 78    | 57    | 44     |
| CNM (Queretaro)               |        | -20                                     | -5    | 20    | 46     |
| CRL (Tokyo)                   |        | -101                                    | -111  | -105  | -107   |
| CSAO (Lintong)                |        | -52                                     | -20   | -35   | -38    |
| CSIR (Pretoria)               |        | -3059                                   | -3127 | -3220 | -3313  |
| DLR (Oberpfaffenhofen)        |        | -2325                                   | -2370 | -2419 | -2463  |
| DTAG (Darmstadt)              |        | -223                                    | -222  | -204  | -196   |
| GUM (Warszawa)                |        | 968                                     | 974   | 994   | 999    |
| IEN (Torino)                  |        | 71                                      | 72    | 66    | 61     |
| IFAG (Wettzell)               |        | -2132                                   | -2137 | -2128 | -2144  |
| IGMA (Buenos Aires)           |        | 97                                      | 115   | 106   | 104    |
| INPL (Jerusalem)              |        | -65                                     | -89   | -119  | -151   |
| IPQ (Monte de Caparica)       |        | 121                                     | 139   | 156   | 176    |
| JATC (Lintong)                |        | 3371                                    | 3405  | 3398  | 3389   |
| KRIS (Taejon)                 |        | 109                                     | 123   | 134   | 132    |
| LDS (Leeds)                   |        | 152                                     | 162   | 160   | 159    |
| MSL (Lower Hutt)              |        | -5482                                   | -5415 | -5352 | -5336  |
| NAO (Mizusawa)                |        | 753                                     | 823   | 878   | 942    |
| NIM (Beijing)                 |        | -2657                                   | -2672 | -2691 | -2678  |
| NIST (Boulder)                |        | 15                                      | 16    | 18    | 22     |
| NML (Sydney)                  |        | 974                                     | 988   | 1009  | 1029   |
| NPL (Teddington)              |        | 71                                      | 76    | 77    | 81     |
| NRC (Ottawa)                  |        | 26                                      | 24    | 18    | 16     |
| NRLM (Tsukuba)                |        | 385                                     | 391   | 401   | 410    |
| OMH (Budapest)                |        | 1623                                    | 1645  | 1640  | 1664   |
| ONBA (Buenos Aires)           |        | 1800                                    | 2106  | 2354  | 2638   |
| ONRJ (Rio de Janeiro)         |        | 419                                     | 450   | 471   | 497    |
| OP (Paris)                    |        | 11                                      | 7     | 17    | 28     |
| ORB (Bruxelles)               |        | 245                                     | 277   | 265   | 262    |
| PSB (Singapore)               |        | 1257                                    | 1282  | 1308  | 1334   |
| PTB (Braunschweig)            |        | 15                                      | 18    | 28    | 39     |
| ROA (San Fernando)            |        | 28                                      | 31    | 26    | 16     |
| SCL (Hong Kong)               |        | -327                                    | -326  | -288  | -261   |
| SO (Shanghai)                 |        | 781                                     | 781   | 751   | 758    |
| SP (Boras)                    |        | 673                                     | 674   | 677   | 683    |
| SU (Moskva)                   |        | 292                                     | 288   | 282   | 284    |
| TL (Chung-Li)                 |        | 396                                     | 389   | 389   | 355    |
| TP (Praha)                    |        | 210                                     | 207   | 200   | 204    |
| TUG (Graz)                    |        | 4563                                    | 4621  | 4669  | 4727   |
| UME (Gebze-Kocaeli)           |        | 1077                                    | 1094  | 1100  | 1110   |
| USNO (Washington DC)(USNO MC) |        | 10                                      | 12    | 12    | 16     |
| VSL (Delft)                   |        | -35                                     | -35   | -34   | -30    |



## 1 - Coordinated Universal Time UTC. (Cont.)

| Date 1998    | 0h UTC                   | Mar 17     | Mar 22                   | Mar 27 |
|--------------|--------------------------|------------|--------------------------|--------|
|              | MJD                      | 50889      | 50894                    | 50899  |
| Laboratory k |                          | UTC-UTC(k) | (Unit is one nanosecond) |        |
| AOS          | (Borowiec)               | -334       | -280                     | -189   |
| APL          | (Laurel)                 | 5576       | 5635                     | 5686   |
| AUS          | (Canberra)               | 306        | 326                      | 320    |
| BIRM         | (Beijing)                | -          | -                        | -9055  |
| CAO          | (Cagliari)               | -2405      | -2436                    | -2462  |
| CH           | (Bern)                   | 47         | 44                       | 61     |
| CNM          | (Queretaro)              | 66         | 83                       | 96     |
| CRL          | (Tokyo)                  | -110       | -110                     | -112   |
| CSAO         | (Lintong)                | -36        | -36                      | -60    |
| CSIR         | (Pretoria)               | -3382      | -3451                    | -3542  |
| DLR          | (Oberpfaffenhofen)       | -2510      | -2559                    | -2607  |
| DTAG         | (Darmstadt)              | (1) -177   | -168                     | -110   |
| GUM          | (Warszawa)               | 996        | 997                      | 999    |
| IEN          | (Torino)                 | 53         | 32                       | 27     |
| IFAG         | (Wettzell)               | -2140      | -2152                    | -2185  |
| IGMA         | (Buenos Aires)           | 110        | 106                      | 113    |
| INPL         | (Jerusalem)              | -188       | -221                     | -252   |
| IPQ          | (Monte de Caparica)      | 200        | 218                      | 246    |
| JATC         | (Lintong)                | 3396       | 3404                     | 3378   |
| KRIS         | (Taejon)                 | 140        | 140                      | 150    |
| LDS          | (Leeds)                  | 171        | 182                      | 176    |
| MSL          | (Lower Hutt)             | -5289      | -5242                    | -5205  |
| NAO          | (Mizusawa)               | 999        | 1068                     | 1122   |
| NIM          | (Beijing)                | -2690      | -2689                    | -2677  |
| NIST         | (Boulder)                | 22         | 24                       | 25     |
| NML          | (Sydney)                 | 1057       | 1086                     | 1122   |
| NPL          | (Teddington)             | 84         | 85                       | 88     |
| NRC          | (Ottawa)                 | 14         | 22                       | 20     |
| NRLM         | (Tsukuba)                | 421        | 426                      | 437    |
| OMH          | (Budapest)               | 1680       | 1690                     | 1698   |
| ONBA         | (Buenos Aires)           | 2885       | 3163                     | 3324   |
| ONRJ         | (Rio de Janeiro)         | 523        | 538                      | 564    |
| OP           | (Paris)                  | 22         | 21                       | 15     |
| ORB          | (Bruxelles)              | 255        | 246                      | 242    |
| PSB          | (Singapore)              | 1353       | -                        | 201    |
| PTB          | (Braunschweig)           | 42         | 46                       | 52     |
| ROA          | (San Fernando)           | 13         | 9                        | 8      |
| SCL          | (Hong Kong)              | -235       | -192                     | -159   |
| SO           | (Shanghai)               | 751        | 752                      | 746    |
| SP           | (Boras)                  | (2) 699    | 723                      | 726    |
| SU           | (Moskva)                 | 266        | 269                      | 263    |
| TL           | (Chung-Li)               | 350        | 345                      | 342    |
| TP           | (Praha)                  | 209        | 200                      | 213    |
| TUG          | (Graz)                   | 4781       | 4832                     | 4879   |
| UME          | (Gebze-Kocaeli)          | 1128       | 1135                     | 1143   |
| USNO         | (Washington DC)(USNO MC) | 17         | 19                       | 18     |
| VSL          | (Delft)                  | -33        | -18                      | -6     |



## 2 - International Atomic Time TAI and local atomic time scales TA(k).

The following table gives the computed values of  $TAI - TA(k)$ .

| Date 1998 0h UTC<br>MJD<br>Laboratory k | Feb 25<br>50869<br>$TAI - TA(k)$ | Mar 2<br>50874<br>(Unit is one nanosecond) | Mar 7<br>50879 | Mar 12<br>50884 |
|---|----------------------------------|--|----------------|-----------------|
| AMC (Col. Springs)                      | -365193                          | -365198                                    | -365203        | -365205         |
| APL (Laurel)                            | 6846                             | 6896                                       | 6939           | 6989            |
| AUS (Canberra)                          | -84145                           | -84252                                     | -84343         | -84446          |
| CH (Bern)                               | -37633                           | -37447                                     | -37277         | -37099          |
| CRL (Tokyo)                             | 96622                            | 96824                                      | 97040          | 97246           |
| CSAO (Lintong)                          | -1805                            | -1773                                      | -1838          | -1891           |
| F (Paris)                               | 162708                           | 162702                                     | 162701         | 162701          |
| IEN (Torino)                            | 5763                             | 5816                                       | 5862           | 5907            |
| INPL (Jerusalem)                        | -65                              | -89  | -119           | -151            |
| JATC (Lintong)                          | 10071                            | 10021                                      | 9943           | 9857            |
| KRIS (Taejon)                           | 5588                             | 5619                                       | 5648           | 5659            |
| NIST (Boulder)                          | -45172577                        | -45172789                                  | -45172999      | -45173208       |
| NML (Sydney)                            | 1012                             | 1026                                       | 1047           | 1067            |
| NRC (Ottawa)                            | 27009                            | 27007                                      | 27001          | 26999           |
| PTB (Braunschweig)                      | -361485                          | -361482                                    | -361472        | -361461         |
| SO (Shanghai)                           | -46779                           | -  | -              | -               |
| SU (Moskva) (3)                         | 27241292                         | 27241288                                   | 27241282       | 27241284        |
| USNO (Washington DC)                    | -34789778                        | -34790092                                  | -34790409      | -34790722       |

| Date 1998 0h UTC<br>MJD<br>Laboratory k | Mar 17<br>50889<br>$TAI - TA(k)$ | Mar 22<br>50894<br>(Unit is one nanosecond) | Mar 27<br>50899 |
|---|----------------------------------|---|-----------------|
| AMC (Col. Springs)                      | -365211                          | -365213                                     | -365219         |
| APL (Laurel)                            | 7039                             | 7098  | 7149            |
| AUS (Canberra)                          | -84559                           | -84645                                      | -84767          |
| CH (Bern)                               | -36905                           | -36717                                      | -36509          |
| CRL (Tokyo)                             | 97457                            | 97667                                       | 97879           |
| CSAO (Lintong)                          | -1939                            | -1989                                       | -2063           |
| F (Paris)                               | 162697                           | 162692                                      | 162688          |
| IEN (Torino)                            | 5949                             | 5980  | 6024            |
| INPL (Jerusalem)                        | -188                             | -221  | -252            |
| JATC (Lintong)                          | 9748                             | 9670  | 9591            |
| KRIS (Taejon)                           | 5688                             | 5705  | 5730            |
| NIST (Boulder)                          | -45173420                        | -45173631                                   | -45173842       |
| NML (Sydney)                            | 1094                             | 1124  | 1160            |
| NRC (Ottawa)                            | 26998                            | 27006                                       | 27004           |
| PTB (Braunschweig)                      | -361458                          | -361454                                     | -361448         |
| SO (Shanghai)                           | -                                | -   | -               |
| SU (Moskva) (3)                         | 27241266                         | 27241269                                    | 27241263        |
| USNO (Washington DC)                    | -34791037                        | -34791350                                   | -34791668       |



## 3 - Notes on sections 1 and 2.

- (1) DTAG . Apparent time step of  $UTC-UTC(DTAG)$  of + 85 ns between MJD = 50894 and MJD = 50899.
- (2) SP . Time step of  $UTC-UTC(SP)$  of - 43 ns between MJD = 50884 and MJD = 50889 due to GPS link calibration.
- (3) SU . Listed values are  $TAI-TA(SU)$  - 2.80 seconds.

## 4 - Difference between the normalized frequencies of EAL and TAI.

| Interval of validity                             |             | $f(EAL)-f(TAI)$         |
|--|-------------|-------------------------|
| 1998 Feb. 25 - 1998 Mar. 27                      | 50869-50899 | $7.140 \times 10^{-13}$ |
| New steering correction foreseen for April 1998  |             |                         |
| 1998 Mar. 27 - 1998 Apr. 26                      | 50899-50929 | $7.130 \times 10^{-13}$ |
| No new steering correction foreseen for May 1998 |             |                         |
| 1998 Apr. 26 - 1998 May 31                       | 50929-50964 | $7.130 \times 10^{-13}$ |

## 5 - Duration of the TAI scale interval.

The following table gives the duration  $u_{TAI}$  of the TAI scale interval expressed as its relative departure  $d$  from the SI second on the rotating geoid,  $u_0$ , together with its uncertainty  $\sigma$  :  $d = (u_{TAI}-u_0)/u_0$ . This is obtained, on the given period of estimation, by comparison of the TAI frequency :

- with the frequency, corrected for the black-body radiation shift, of a given individual primary frequency standard ( $\sigma$  is then the last communicated estimate of the type B uncertainty of the standard), and
- with a combination computed by the BIPM of all available measurements from LPTF-F01, NIST-7, PTB CS2 and PTB CS3 consistently corrected for the black-body radiation shift ( $\sigma$  is then estimated by the BIPM taking into account the individual uncertainties and parameters characteristic of TAI stability).

| Standard      | Period of estimation | $d$<br>( $10^{-14}$ ) | $\sigma$<br>( $10^{-14}$ ) |
|---------------|----------------------|-----------------------|----------------------------|
| PTB-CS2       | 50869-50899          | +0.2                  | 1.5                        |
| PTB-CS3       | 50869-50899          | +3.2                  | 1.4                        |
| NIST-7        | 50879-50889          | -0.9                  | 1.0                        |
| BIPM estimate | 50844-50899          | +0.4                  | 1.0                        |



6 - [UTC-GPS time] and [TAI-GPS time].

$$[UTC\text{-}GPS\ time] = -12\ \text{s} + C_0, \quad [TAI\text{-}GPS\ time] = 19\ \text{s} + C_0.$$

Daily values of  $C_0$  are given in the following table. They are obtained as follows: the GPS data taken at the Paris Observatory, for highest elevation, are first corrected for precise satellite ephemerides and for measured ionospheric delays, and then smoothed to obtain daily values of  $[UTC(OP)\text{-}GPS\ time]$  at 0h UTC; daily values of  $C_0$  are derived from them using linear interpolation of  $[UTC\text{-}UTC(OP)]$ . The global uncertainty of daily  $C_0$  values is of order 10 ns.

In the following table, the standard deviation  $\sigma$  characterizes the dispersion of individual measurements, and  $N$  is the number of measurements used on a given day for estimation of the corresponding daily  $C_0$  value.

| Date<br>1998<br>0h UTC | MJD   | $C_0$<br>(ns) | $\sigma$<br>(ns) | $\sigma/\sqrt{N}$<br>(ns) |
|------------------------|-------|---------------|------------------|---------------------------|
| Feb 25                 | 50869 | -1            | 45               | 8                         |
| Feb 26                 | 50870 | -3            | 46               | 7                         |
| Feb 27                 | 50871 | 5             | 41               | 6                         |
| Feb 28                 | 50872 | 10            | 44               | 7                         |
| Mar 1                  | 50873 | 9             | 36               | 5                         |
| Mar 2                  | 50874 | 4             | 52               | 8                         |
| Mar 3                  | 50875 | 4             | 56               | 9                         |
| Mar 4                  | 50876 | 5             | 38               | 6                         |
| Mar 5                  | 50877 | 5             | 47               | 7                         |
| Mar 6                  | 50878 | 6             | 45               | 7                         |
| Mar 7                  | 50879 | 12            | 51               | 8                         |
| Mar 8                  | 50880 | 19            | 34               | 6                         |
| Mar 9                  | 50881 | 16            | 39               | 6                         |
| Mar 10                 | 50882 | 11            | 42               | 7                         |
| Mar 11                 | 50883 | 12            | 43               | 6                         |
| Mar 12                 | 50884 | 14            | 38               | 6                         |
| Mar 13                 | 50885 | 12            | 27               | 6                         |
| Mar 14                 | 50886 | 10            | 39               | 6                         |
| Mar 15                 | 50887 | 10            | 53               | 8                         |
| Mar 16                 | 50888 | 10            | 43               | 13                        |
| Mar 17                 | 50889 | 7             | 36               | 8                         |
| Mar 18                 | 50890 | 6             | 53               | 13                        |
| Mar 19                 | 50891 | 12            | 36               | 6                         |
| Mar 20                 | 50892 | 21            | 43               | 12                        |
| Mar 21                 | 50893 | 26            | 38               | 8                         |
| Mar 22                 | 50894 | 20            | 38               | 7                         |
| Mar 23                 | 50895 | 8             | 41               | 15                        |
| Mar 24                 | 50896 | 0             | 44               | 8                         |
| Mar 25                 | 50897 | 5             | 51               | 12                        |
| Mar 26                 | 50898 | 12            | 46               | 8                         |
| Mar 27                 | 50899 | 16            | 49               | 12                        |



7 - [UTC-GLOASS time] and [TAI-GLOASS time].

$$[UTC\text{-GLOASS time}] = 0 \text{ s} + C_1, \quad [TAI\text{-GLOASS time}] = +31 \text{ s} + C_1.$$

Daily values of  $C_1$  are given in the following table. They are obtained as follows: the GLOASS data taken at the NMi Van Swinden Laboratorium, Delft, The Netherlands, for highest elevation, are smoothed to obtain daily values of [UTC(VSL)-GLOASS time] at 0h UTC; daily values of  $C_1$  are then derived from them using linear interpolation of [UTC-UTC(VSL)]. A time correction of + 1285 ns is also applied in order to ensure continuity of  $C_1$  estimates on 1997, January 1 (MJD = 50449). The global uncertainty of daily  $C_1$  values is of order several hundreds of nanoseconds.

In the following table, the standard deviation  $\sigma$  characterizes the dispersion of individual measurements, and  $N$  is the number of measurements used on a given day for estimation of the corresponding daily  $C_1$  value.

| Date   |       |               |                  |                           |  |
|--------|-------|---------------|------------------|---------------------------|--|
| 1998   | MJD   | $C_1$<br>(ns) | $\sigma$<br>(ns) | $\sigma/\sqrt{N}$<br>(ns) |  |
| 0h UTC |       |               |                  |                           |  |
| Feb 25 | 50869 | 394           | 24               | 6                         |  |
| Feb 26 | 50870 | 397           | 15               | 4                         |  |
| Feb 27 | 50871 | 389           | 18               | 5                         |  |
| Feb 28 | 50872 | 387           | 24               | 4                         |  |
| Mar 1  | 50873 | 393           | 20               | 3                         |  |
| Mar 2  | 50874 | 393           | 19               | 3                         |  |
| Mar 3  | 50875 | 381           | 20               | 3                         |  |
| Mar 4  | 50876 | 372           | 16               | 3                         |  |
| Mar 5  | 50877 | 376           | 19               | 3                         |  |
| Mar 6  | 50878 | 382           | 23               | 4                         |  |
| Mar 7  | 50879 | 384           | 26               | 5                         |  |
| Mar 8  | 50880 | 385           | 23               | 4                         |  |
| Mar 9  | 50881 | 382           | 21               | 3                         |  |
| Mar 10 | 50882 | 375           | 19               | 3                         |  |
| Mar 11 | 50883 | 371           | 29               | 5                         |  |
| Mar 12 | 50884 | 370           | 19               | 3                         |  |
| Mar 13 | 50885 | 372           | 18               | 3                         |  |
| Mar 14 | 50886 | 383           | 17               | 3                         |  |
| Mar 15 | 50887 | 390           | 18               | 3                         |  |
| Mar 16 | 50888 | 389           | 22               | 4                         |  |
| Mar 17 | 50889 | 378           | 16               | 2                         |  |
| Mar 18 | 50890 | 371           | 19               | 3                         |  |
| Mar 19 | 50891 | 367           | 22               | 4                         |  |
| Mar 20 | 50892 | 375           | 21               | 3                         |  |
| Mar 21 | 50893 | 389           | 18               | 3                         |  |
| Mar 22 | 50894 | 395           | 17               | 3                         |  |
| Mar 23 | 50895 | 389           | 24               | 4                         |  |
| Mar 24 | 50896 | 387           | 24               | 4                         |  |
| Mar 25 | 50897 | 388           | 19               | 3                         |  |
| Mar 26 | 50898 | 388           | 22               | 4                         |  |
| Mar 27 | 50899 | 386           | 16               | 3                         |  |

