

1 - Coordinated Universal Time UTC. Computed values of UTC-UTC(k).

(Since 1991 January 1, 0hUTC, TAI-UTC=26s)

| Date 1991 0hUTC               | Nov 29                            | Dec 9   | Dec 19  | Dec 29  |
|-------------------------------|-----------------------------------|---------|---------|---------|
| MJD                           | 48589                             | 48599   | 48609   | 48619   |
| Laboratory k                  | UTC-UTC(k) (Unit = 1 microsecond) |         |         |         |
| AOS (Borowiec)                | 0.44                              | -1.12   | -1.41   | -2.15   |
| APL (Laurel)                  | -1.10                             | -1.06   | -1.03   | -0.98   |
| AUS (Canberra)                | 0.18                              | 0.20    | 0.22    | 0.23    |
| BEV (Wien)                    | 3.08                              | 2.79    | 2.05    | 1.25    |
| CAO (Cagliari)                | 0.06                              | -0.06   | -0.85   | -1.58   |
| CH (Bern)                     | 1.30                              | 1.26    | 1.24    | 1.24    |
| CRL (Tokyo)                   | 2.42                              | 2.48    | 2.55    | 2.53    |
| CSAO (Lintong)                | -2.76                             | -2.66   | -2.67   | -2.61   |
| DPT (Pretoria)                | -24.58                            | -24.58  | -24.56  | -24.50  |
| FTZ (Darmstadt)               | 23.24                             | 23.21   | 23.21   | 23.34   |
| IEN (Torino)                  | -1.25                             | -1.21   | -1.13   | -1.09   |
| IFAG (Wetzell)                | 1.42                              | 1.52    | 1.43    | 1.42    |
| IGMA (Buenos Aires)           | -1.38                             | -1.37   | -1.37   | -1.34   |
| INPL (Jerusalem)              | -1.19                             | -1.31   | -1.44   | -1.56   |
| JATC (Lintong)                | -26.45                            | -26.47  | -26.60  | -26.60  |
| KRIS (Taejon)                 | 0.58                              | 0.55    | 0.50    | 0.44    |
| LDS (Leeds)                   | -15.40                            | -       | -       | -       |
| NAOM (Mizusawa)               | -8.30                             | -8.10   | -7.90   | -7.71   |
| NIM (Beijing)                 | 8.14                              | 8.14    | 8.14    | 8.07    |
| NIST (Boulder)                | -0.93                             | -0.89   | -0.84   | -0.79   |
| NMC (Sofiya)                  | -3.72                             | -3.00   | -2.24   | -0.94   |
| NPL (Teddington)              | -0.29                             | -0.21   | -0.12   | -0.03   |
| NPLI (New-Delhi)              | 9.96                              | 11.84   | 13.74   | 15.53   |
| NRC (Ottawa)                  | 1.67                              | 1.58    | 1.51    | 1.43    |
| NRLM (Tsukuba)                | -99.47                            | -105.99 | -112.60 | -119.45 |
| OMH (Budapest)                | 3.16                              | 2.84    | 2.68    | -       |
| ONRJ (Rio de Janeiro)         | -                                 | -       | -       | -       |
| OP (Paris)                    | -0.65                             | -0.69   | -0.68   | -0.65   |
| ORB (Bruxelles)               | 1.62                              | 1.67    | 1.74    | 1.50    |
| PEL (Lower Hutt)              | -1.42                             | -1.41   | -1.46   | -1.35   |
| PKNM (Warszawa)               | -0.07                             | 0.07    | 0.01    | 0.02    |
| PTB (Braunschweig)            | 3.32                              | 3.30    | 3.30    | 3.29    |
| RC (Habana)                   | -2.33                             | -2.17   | -2.10   | -2.55   |
| ROA (San Fernando)            | 5.12                              | 5.00    | 4.90    | 4.80    |
| SNT (Stockholm)               | 0.10                              | 0.15    | 0.13    | 0.15    |
| SO (Shanghai)                 | 2.46                              | 2.58    | 2.49    | 2.43    |
| SU (Moskva) (1)               | 4.63                              | 4.57    | 4.48    | 4.42    |
| TAO (Tokyo)                   | 1.25                              | 1.26    | 1.26    | 1.25    |
| TL (Chung-Li)                 | 2.53                              | 2.41    | 2.29    | 2.14    |
| TP (Praha)                    | -0.78                             | -0.93   | -1.09   | -1.27   |
| TUG (Graz)                    | 1.53                              | 1.84    | 2.18    | 2.56    |
| USNO (Washington DC)(USNO MC) | 0.18                              | 0.20    | 0.22    | 0.23    |
| VSL (Delft)                   | 2.13                              | 2.27    | 2.40    | 2.47    |
| YUZH (Beograd)                | -                                 | -       | -       | -       |

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

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

| Date 1991 0hUTC          | Nov 29                           | Dec 9      | Dec 19     | Dec 29     |
|--------------------------|----------------------------------|------------|------------|------------|
| MJD                      | 48589                            | 48599      | 48609      | 48619      |
| Laboratory k             | TAI-TA(k) (Unit = 1 microsecond) |            |            |            |
| APL (Laurel)             | -1.61                            | -1.57      | -1.54      | -1.49      |
| AUS (Canberra)           | -38.25                           | -38.41     | -38.54     | -38.57     |
| CH (Bern)                | -71.85                           | -71.97     | -72.05     | -72.12     |
| CRL (Tokyo)              | 7.15                             | 7.41       | 7.67       | 7.94       |
| CSAO (Lintong)           | 23.48                            | 23.38      | 23.17      | 23.03      |
| F (Paris)                | 97.47                            | 97.77      | 98.10      | 98.42      |
| JATC (Lintong)           | -0.45                            | -0.20      | -0.22      | -0.16      |
| KRIS (Taejon)            | -23.47                           | -23.78     | -24.16     | -24.54     |
| NIM (Beijing)            | -10.05                           | -10.03     | -10.01     | -10.06     |
| NISA (Boulder) (2)       | -45080.21                        | -45080.55  | -45080.89  | -45081.23  |
| NIST (Boulder)           | -45178.46                        | -45179.13  | -45179.78  | -45180.43  |
| NRC (Ottawa)             | 17.74                            | 17.65      | 17.58      | 17.50      |
| PTB (Braunschweig)       | -360.08                          | -360.10    | -360.10    | -360.11    |
| RC (Habana) (3)          | -296.91                          | -297.40    | -297.55    | -297.83    |
| SO (Shanghai)            | -44.96                           | -44.84     | -44.93     | -45.00     |
| SU (Moskva)              | 2827254.63                       | 2827254.57 | 2827254.48 | 2827254.42 |
| USNO (Washington DC) (4) | -34638.27                        | -34638.93  | -34639.60  | -34640.28  |

## 3 - Notes on sections 1 and 2.

(1) SU . Time transfer data obtained from GLONASS satellite trackings at the University of Leeds (U.K.) and SU. See Section 5.

(2) TA(NISA) designates the scale AT1 of NIST.

(3) RC . Listed values are TAI-TA(RC) - 18 seconds.

(4) TA(USNO) designates the scale A1(MEAN) of USNO.

## 4 - UTC - GPS time and TAI - GPS time.

UTC - GPS time = -7s + C0, TAI - GPS time = 19s + C0.

The GPS data are taken at the Paris Observatory, from Block I satellites, and are usually corrected for the measured ionospheric delays. They are smoothed to obtain daily values of UTC(OP) - GPS time at 0hUTC. UTC - GPS time is derived from them using linear interpolation of UTC - UTC(OP).

The r values are the residuals to the smoothed data for the middle of the 13-minute tracking period. The reference times are given for the first date of the table only. The r values are reported here only to show the quality of the synchronization.

UTC may be derived at any site from observation of any listed satellite, by interpolating C0 to the tracking time. The quality of the access to UTC mainly depends upon local conditions of observation.

| Date<br>1991<br>0hUTC | MJD   | C0<br>(ns) | r(ns) Block I            |                          |                         |                         |                          |
|-----------------------|-------|------------|--------------------------|--------------------------|-------------------------|-------------------------|--------------------------|
|                       |       |            | PRN 6<br>NAV 3<br>21h12m | PRN12<br>NAV10<br>22h48m | PRN 3<br>NAV11<br>2h36m | PRN11<br>NAV 8<br>7h 8m | PRN13<br>NAV 9<br>13h16m |
| Nov 29                | 48589 | 213        | -10                      | -                        | -6                      | -16                     | -                        |
| Nov 30                | 48590 | 214        | -9                       | 10                       | 8                       | -                       | -3                       |
| Dec 1                 | 48591 | 213        | -11                      | -                        | -2                      | 6                       | -2                       |
| Dec 2                 | 48592 | 213        | 1                        | 6                        | -3                      | -1                      | -4                       |
| Dec 3                 | 48593 | 216        | -9                       | -11                      | 2                       | -4                      | -1                       |
| Dec 4                 | 48594 | 227        | -1                       | -7                       | 1                       | 12                      | 17                       |
| Dec 5                 | 48595 | 240        | -12                      | -                        | 1                       | -1                      | -5                       |
| Dec 6                 | 48596 | 249        | -                        | -                        | -5                      | 9                       | 1                        |
| Dec 7                 | 48597 | 256        | -7                       | -                        | 8                       | -5                      | -5                       |
| Dec 8                 | 48598 | 260        | 0                        | 7                        | -11                     | -1                      | 11                       |
| Dec 9                 | 48599 | 266        | -8                       | 6                        | -1                      | 8                       | 8                        |
| Dec 10                | 48600 | 273        | -14                      | -3                       | -2                      | -9                      | -11                      |
| Dec 11                | 48601 | 277        | 1                        | -                        | 5                       | -9                      | 17                       |
| Dec 12                | 48602 | 275        | -                        | -                        | 7                       | -6                      | -7                       |

| Date<br>1991<br>0hUTC | MJD   | C0<br>(ns) | r(ns) Block I           |                         |                          |                          |                          |
|-----------------------|-------|------------|-------------------------|-------------------------|--------------------------|--------------------------|--------------------------|
|                       |       |            | PRN 3<br>NAV11<br>1h28m | PRN11<br>NAV 8<br>6h 0m | PRN13<br>NAV 9<br>11h52m | PRN 6<br>NAV 3<br>17h28m | PRN12<br>NAV10<br>20h24m |
| Dec 13                | 48603 | 271        | -5                      | 10                      | -6                       | 7                        | -16                      |
| Dec 14                | 48604 | 272        | -6                      | 4                       | 4                        | 4                        | 1                        |
| Dec 15                | 48605 | 271        | 1                       | 1                       | -                        | -2                       | -                        |
| Dec 16                | 48606 | 268        | -10                     | -9                      | 4                        | 10                       | -                        |
| Dec 17                | 48607 | 267        | -2                      | -1                      | -3                       | 0                        | -6                       |
| Dec 18                | 48608 | 268        | -1                      | 8                       | 4                        | -2                       | -18                      |
| Dec 19                | 48609 | 269        | -4                      | 0                       | 13                       | 8                        | -8                       |
| Dec 20                | 48610 | 268        | 1                       | -2                      | 4                        | 13                       | -18                      |
| Dec 21                | 48611 | 263        | -1                      | -4                      | -9                       | 7                        | 4                        |
| Dec 22                | 48612 | 260        | -7                      | 2                       | 0                        | -                        | -                        |
| Dec 23                | 48613 | 259        | 4                       | 8                       | -1                       | 0                        | -10                      |
| Dec 24                | 48614 | 257        | -2                      | -5                      | 14                       | 7                        | -                        |
| Dec 25                | 48615 | 256        | -5                      | 0                       | 9                        | 2                        | -18                      |
| Dec 26                | 48616 | 260        | 2                       | -5                      | 1                        | -5                       | 2                        |
| Dec 27                | 48617 | 266        | 5                       | -7                      | 19                       | 4                        | -4                       |
| Dec 28                | 48618 | 269        | -11                     | 4                       | -                        | -3                       | -                        |
| Dec 29                | 48619 | 269        | 6                       | -9                      | 3                        | 2                        | -                        |

## Section 4 (Cont.)

For Block II satellites, the  $r$  values are computed with respect to  $C_0$  obtained from Block I only.

|                       |       | r(ns) Block II |                          |                         |                         |                         |                          |
|-----------------------|-------|----------------|--------------------------|-------------------------|-------------------------|-------------------------|--------------------------|
| Date<br>1991<br>0hUTC | MJD   | $C_0$<br>(ns)  | PRN20<br>NAV20<br>23h36m | PRN17<br>NAV17<br>6h 4m | PRN15<br>NAV15<br>8h28m | PRN21<br>NAV21<br>9h48m | PRN14<br>NAV14<br>11h24m |
| Nov 29                | 48589 | 213            | 32                       | -                       | -                       | 5                       | 12                       |
| Nov 30                | 48590 | 214            | 32                       | 832                     | -                       | 31                      | -2                       |
| Dec 1                 | 48591 | 213            | 15                       | -88                     | 25                      | 90                      | -17                      |
| Dec 2                 | 48592 | 213            | 37                       | 7                       | 66                      | 87                      | -5                       |
| Dec 3                 | 48593 | 216            | 73                       | 3                       | -85                     | 28                      | 26                       |
| Dec 4                 | 48594 | 227            | 24                       | -71                     | -8                      | 76                      | 10                       |
| Dec 5                 | 48595 | 240            | -83                      | 11                      | 45                      | -22                     | -51                      |
| Dec 6                 | 48596 | 249            | 3                        | -31                     | -45                     | -1                      | 59                       |
| Dec 7                 | 48597 | 256            | 34                       | -12                     | 16                      | 74                      | 57                       |
| Dec 8                 | 48598 | 260            | 37                       | 7                       | 36                      | -43                     | -37                      |
| Dec 9                 | 48599 | 266            | -25                      | 30                      | 55                      | 63                      | -25                      |
| Dec 10                | 48600 | 273            | 14                       | -109                    | 33                      | -33                     | -7                       |
| Dec 11                | 48601 | 277            | 50                       | -42                     | 13                      | -46                     | -4                       |
| Dec 12                | 48602 | 275            | -                        | 109                     | 29                      | -30                     | 29                       |

|                       |       | r(ns) Block II |                         |                         |                         |                          |                          |
|-----------------------|-------|----------------|-------------------------|-------------------------|-------------------------|--------------------------|--------------------------|
| Date<br>1991<br>0hUTC | MJD   | $C_0$<br>(ns)  | PRN23<br>NAV23<br>4h 8m | PRN17<br>NAV17<br>4h56m | PRN15<br>NAV15<br>7h 4m | PRN14<br>NAV14<br>10h 0m | PRN18<br>NAV18<br>11h 4m |
| Dec 13                | 48603 | 271            | 1                       | 60                      | -                       | 8                        | 17                       |
| Dec 14                | 48604 | 272            | -17                     | -44                     | 13                      | 59                       | 55                       |
| Dec 15                | 48605 | 271            | 19                      | -23                     | -2                      | 42                       | -26                      |
| Dec 16                | 48606 | 268            | 22                      | -43                     | -11                     | 19                       | 0                        |
| Dec 17                | 48607 | 267            | 78                      | -8                      | -11                     | -39                      | -49                      |
| Dec 18                | 48608 | 268            | -26                     | -23                     | 15                      | 43                       | 0                        |
| Dec 19                | 48609 | 269            | -                       | 11                      | -34                     | 39                       | 7                        |
| Dec 20                | 48610 | 268            | 27                      | -68                     | 11                      | 44                       | 46                       |
| Dec 21                | 48611 | 263            | 67                      | 2                       | 64                      | -45                      | -53                      |
| Dec 22                | 48612 | 260            | 37                      | -46                     | -8                      | -77                      | 31                       |
| Dec 23                | 48613 | 259            | -66                     | -                       | -11                     | 30                       | 65                       |
| Dec 24                | 48614 | 257            | 51                      | -12                     | 74                      | 44                       | -56                      |
| Dec 25                | 48615 | 256            | 70                      | -23                     | -44                     | 53                       | -19                      |
| Dec 26                | 48616 | 260            | -34                     | 26                      | -33                     | 18                       | 42                       |
| Dec 27                | 48617 | 266            | 38                      | 58                      | 29                      | 53                       | -28                      |
| Dec 28                | 48618 | 269            | -12                     | 24                      | 21                      | -                        | -                        |
| Dec 29                | 48619 | 269            | -2                      | -79                     | 16                      | 10                       | -                        |

## Section 4 (Cont.)

| Date<br>1991<br>0hUTC | MJD   | C0<br>(ns) | r(ns) Block II           |                          |                          |                          |                          |
|-----------------------|-------|------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
|                       |       |            | PRN18<br>NAV18<br>14h 0m | PRN16<br>NAV16<br>17h12m | PRN19<br>NAV19<br>17h44m | PRN 2<br>NAV13<br>20h24m | PRN23<br>NAV23<br>20h56m |
| Nov 29                | 48589 | 213        | 7                        | -                        | -1                       | 4                        | 17                       |
| Nov 30                | 48590 | 214        | 0                        | -421                     | -6                       | 93                       | 60                       |
| Dec 1                 | 48591 | 213        | -                        | -58                      | -18                      | 6                        | 31                       |
| Dec 2                 | 48592 | 213        | -35                      | -21                      | 29                       | 1                        | 13                       |
| Dec 3                 | 48593 | 216        | 62                       | -87                      | -9                       | -7                       | 0                        |
| Dec 4                 | 48594 | 227        | 70                       | -17                      | 11                       | 104                      | -31                      |
| Dec 5                 | 48595 | 240        | -19                      | 9                        | -33                      | -1                       | 41                       |
| Dec 6                 | 48596 | 249        | 17                       | 64                       | 12                       | -54                      | -                        |
| Dec 7                 | 48597 | 256        | -20                      | 2                        | 9                        | -10                      | -13                      |
| Dec 8                 | 48598 | 260        | -22                      | -                        | 7                        | 0                        | -60                      |
| Dec 9                 | 48599 | 266        | 76                       | 87                       | -35                      | -1                       | 59                       |
| Dec 10                | 48600 | 273        | -19                      | 65                       | -8                       | -13                      | -                        |
| Dec 11                | 48601 | 277        | -15                      | -4                       | 0                        | 32                       | 49                       |
| Dec 12                | 48602 | 275        | 21                       | -                        | -                        | -                        | -                        |

| Date<br>1991<br>0hUTC | MJD   | C0<br>(ns) | r(ns) Block II           |                          |                          |                          |                          |
|-----------------------|-------|------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
|                       |       |            | PRN24<br>NAV24<br>13h28m | PRN19<br>NAV19<br>13h44m | PRN16<br>NAV16<br>15h52m | PRN 2<br>NAV13<br>19h20m | PRN20<br>NAV20<br>22h32m |
| Dec 13                | 48603 | 271        | 47                       | -36                      | 7                        | 22                       | 26                       |
| Dec 14                | 48604 | 272        | 30                       | -10                      | 46                       | 38                       | 5                        |
| Dec 15                | 48605 | 271        | -16                      | -10                      | -63                      | 32                       | -81                      |
| Dec 16                | 48606 | 268        | -                        | -23                      | 25                       | 66                       | 5                        |
| Dec 17                | 48607 | 267        | -39                      | -16                      | -43                      | -9                       | 51                       |
| Dec 18                | 48608 | 268        | 7                        | -52                      | -30                      | -28                      | 56                       |
| Dec 19                | 48609 | 269        | -78                      | -44                      | -44                      | 19                       | -12                      |
| Dec 20                | 48610 | 268        | 75                       | 0                        | -28                      | -15                      | -48                      |
| Dec 21                | 48611 | 263        | 2                        | -40                      | -44                      | 31                       | 78                       |
| Dec 22                | 48612 | 260        | 48                       | -11                      | -3                       | -                        | 8                        |
| Dec 23                | 48613 | 259        | -49                      | 17                       | -44                      | 48                       | 36                       |
| Dec 24                | 48614 | 257        | 1                        | -22                      | 0                        | -36                      | -48                      |
| Dec 25                | 48615 | 256        | 23                       | -10                      | -22                      | 93                       | 39                       |
| Dec 26                | 48616 | 260        | -22                      | 18                       | -49                      | 1                        | -4                       |
| Dec 27                | 48617 | 266        | 7                        | -31                      | -35                      | 62                       | -43                      |
| Dec 28                | 48618 | 269        | -                        | -                        | -                        | -                        | -                        |
| Dec 29                | 48619 | 269        | 48                       | 6                        | -1                       | -79                      | 27                       |

## 5 - UTC - GLONASS time.

UTC - GLONASS time = C1 (modulo 1s).

From his current observations of both the GPS and GLONASS satellite systems Prof. P. Daly, University of Leeds, establishes and reports GPS time - GLONASS time at ten-day intervals, together with the standard deviation SD of his daily GLONASS data. C1 is then derived using UTC - GPS time of section 4.

| Date<br>1991<br>0hUTC | MJD   | C1<br>( $\mu$ s) | SD<br>( $\mu$ s) |
|-----------------------|-------|------------------|------------------|
| Nov 29                | 48589 | -7.91            | 0.05             |
| Dec 9                 | 48599 | -8.05            | 0.05             |
| Dec 19                | 48609 | -8.18            | 0.05             |
| Dec 29                | 48619 | -8.30            | 0.06             |

## 6 - Duration of the TAI scale interval.

The following table gives the departure D of the duration of the TAI scale interval from the SI second on the rotating geoid as realized by a given primary frequency standard occasionally evaluated or continuously operating as a clock. In the later case the chosen two-month period of observation is also indicated. The last communicated estimate of the inaccuracy of the standard provides the uncertainty s of the D value.

D and s are expressed in units of  $10^{-14}$  second.

| Standard | Obs. period | D     | s    |
|----------|-------------|-------|------|
| NRC-CsV  | 48559-48619 | +10.0 | 10.0 |
| PTB-CS1  | 48559-48619 | -0.1  | 3.0  |
| PTB-CS2  | 48559-48619 | +1.3  | 1.5  |

The estimate of the duration of the TAI scale interval, computed by the BIPM, from all the available measurements of the TAI frequency, obtained by comparison with primary frequency standards continuously observed or occasionally evaluated (CRL, NIST, NRC, PTB, SU), is:

$$1 + 1 \times 10^{-14} \pm 2 \times 10^{-14}$$

in SI second on the rotating geoid, for the two-month interval 48559-48619 .