Technical Bulletin

GPS to UTC pending leap second

This bulletin describes the forthcoming introduction of the next leap second (Dec 31st 05) and its effect on Navman OEM modules.

UTC background

Historically, time was defined in terms of the rotation of the Earth, known as mean solar time. The reason for using leap seconds is that we currently measure time with stable atomic clocks but the rotation of the Earth has been slowing down. Therefore the time measured by the rotation of the earth has been accumulating a delay with respect to atomic time standards. UTC (Coordinated Universal Time) is measured by atomic clocks, and kept synchronised with mean solar time by introducing a leap second whenever necessary. The decision to introduce a leap second in UTC is the responsibility of the IERS (International Earth Rotation and Reference Systems Service).

The GPS epoch was January 6 1980 and was synchronised to UTC. GPS time is a 'pure' atomic time scale that is not adjusted to account for leap seconds. At the time of writing, GPS time was ahead of UTC by 13 seconds.

In order to relate GPS time to UTC, a set of UTC corrections are available from every tracked satellite as part of the navigation message broadcast (words 6 through 10 of page 18 of subframe 4). For continuously tracked satellites (no blockage), it will take a minimum of 12.5 minutes to gather an updated data set. This includes the current leap second time difference between GPS time and UTC, as well as information on pending leap seconds.

Pending leap second date

The IERS announced in July 2005 that the introduction of the next leap second will be on December 31, 2005. UTC will be retarded by 1.0 second. This pending leap second change was announced through the navigation message on August 3 2005.

Navman OEM modules

Jupiter T and Pico T timing modules (Motorola Binary) were designed to cope with the introduction of future leap seconds because of their use in precision timing applications. All other receivers (as described in this bulletin) do not handle the addition of a leap second quite as well. This can result in a glitch in the time output when the receiver makes the appropriate correction. In most applications where timing is non-critical, this glitch will not be significant.

Jupiter T/Pico T – Timing Modules (Motorola Binary)

UTC correction parameters are maintained in EEPROM. This includes UTC offset and pending leap second information.

When the pending leap second is inserted at midnight on December 31 2005, the time sequence will appear as follows:

23:59:59 Dec 31, 2005
00:00:00 Jan 1, 2006
00:00:00 Jan 1, 2006
00:00:01 Jan 1, 2006

The new UTC offset value (14 seconds) will be written to EEPROM and the pending leap second flag cleared so that the next time the receiver performs a cold start, the correct time is output as soon as it gets a valid fix solution.

Jupiter T/Pico T - Timing Modules (Navman Binary) & Jupiter 11/12/Pico (Zodiac Chipset)

UTC correction parameters are maintained in EEPROM. This only includes UTC offset but does not include pending leap second information.

At midnight on December 31 2005, the receivers will not insert the pending leap second, but will add a second to the time output only after downloading the new UTC offset value from the navigation message, which can take up to 12.5 minutes.

The new UTC offset value (14 seconds) will be written to EEPROM so that the next time the receiver performs a cold start, the correct time is output as soon as it gets a valid fix solution.

Jupiter 20/21/110 (SiRFStarII Chipset)

UTC correction parameters are maintained in BBRAM. This only includes UTC offset but does not include pending leap second information.

The factory default UTC offset value is 13 seconds and stored in non-volatile memory. After a cold start, the receiver uses this to calculate UTC.

At midnight on December 31 2005, the receivers will not insert the pending leap second, but will add a second to the time output only after downloading the new UTC offset value from the navigation message, which can take up to 12.5 minutes.

The new UTC offset value (14 seconds) is stored in BBRAM. Battery back-up is required so that the next time the receiver starts-up, the correct time is output as soon as it gets a valid fix solution. Without battery backup the receiver will use the factory default value (13 seconds) at power-up until the new value (14 seconds) is downloaded from the navigation message.

Callisto (uNav Chipset)

UTC correction parameters are maintained in Flash memory. This only includes UTC offset but does not include pending leap second information.

At midnight on December 31 2005, the receivers will not insert the pending leap second, but will add a second to the time output only after downloading the new UTC offset value from the navigation message, which can take up to 12.5 minutes.

The new UTC offset value (14 seconds) will be written to flash memory so that the next time the receiver performs a cold start, the correct time is output as soon as it gets a valid fix solution.