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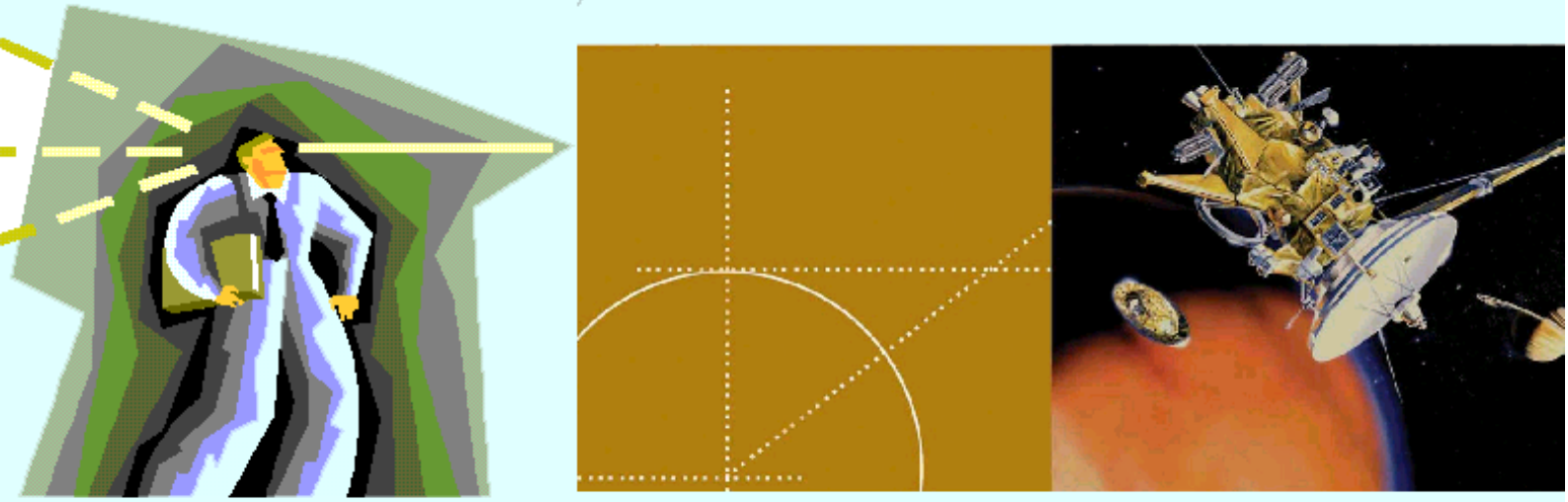

REV 1.0

GPS Receiver/CT-5510 Application Note

1PPS Features

This document describes the 1PPS commands and their use for the CT5510 module.

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Agenda:

In situataions where precise timing pulse is required, 1PPS (One Pulse Per Second) mode allows CT5510 to output timing pulse every second, which is synchronized with the edge of GPS timing second. The 1PPS mode however, requires several precautions for it to operate properly.

Satellite requirements:

The CT5510 requires at least one visible satellite to maintain the pulse precision once the PPS pulse output has started. Having more visible satellites improves the timing performance and reliability. Please notice that during the *survey* and *roving* modes more visible satellites are required to update the antenna location properly. Should the visibility of satellites be lost totally, CT5510 keeps outputting the PPS pulse with its internal clock generator; however, the PPS pulse precision will degrade over time. CT5510 will automatically resynchronize itself to the correct PPS timing and pulse period once the satellite visibility is restored.

PPS pulse.

In PPS operation mode, CT5510 outputs a precise timing pulse exactly once a seconds and is synchronized at the turn of the GPS time seconds. Shortly before each pulse, the CT5510 module outputs a timing message that includes the GPS time and a short-time correction term of the next pulse.

The PPS signal is outputted as an electronic pulse signal from CT5510's PPS connector. The signal length and polarity can be defined by using the NMEA commands PULSELEN and PULSEPOL.

Antenna location

The PPS mode requires precise information of the antenna location in order to enable precisely timed pulse. For versatile applications, CT5510 supports several methods of acquiring the precise antenna position, namely the PPS survey, static and roving modes.

In PPS *survey* and *static* modes the GPS antenna is assumed to stay at a fixed location. In PPS *roving* mode, the antenna may move, but results in worse timing performance.

Navigation data during PPS operation

In the PPS mode, CT5510 navigates and keeps outputting the usual navigation messages. Please notice that in *survey* and *static* modes, CT5510 outputs the averaged or user-defined antenna position instead of the latest temporal position in navigation messages.

Survey mode

The GPS antenna is assumed to stay in a fixed location, and the CT5510 receiver calculates the precise position coordinates of the antenna by averaging the coordinates over numerous navigation fixes. CT5510 starts outputting the PPS pulse within a few seconds after receiving the initial position fix.

The total number of averaged navigation fixes (i.e. the survey time) is defined by using the SURVEYLEN command. After the survey time is completed, CT5510 ceases from averaging the position and the behavior afterwards is identical to the PPS static mode.

During the averaging period, at least four satellites are required for updating the average position. During periods when less than four satellites are visible, the CT5510 module will keep outputting the PPS signal. The remaining survey time however, is extended accordingly.

Static mode

The GPS antenna is assumed to stay in a fixed location, and the user provides the antenna coordinates by using the PPSPOS command. Notice that the precision of antenna coordination is essential for the performance of PPS; if a false or inaccurate coordinate is given; the PPS timing performance diminishes.

In static mode, CT5510 starts outputting the PPS pulse, as soon as one satellite position has been determined and at least one satellite is visible. Notice that CT5510 won’t start outputting the PPS pulse until user has provided the antenna coordinates with the PPSPOS command.

Roving mode

The GPS antenna coordinate is determined from the latest navigation fix alone, thus the antenna may have moved during PPS operation. The antenna position precision in roving mode is thus worse than in *static* or *survey* modes, and the timing performance is also worse. The typical timing precision in roving mode is around 30 nanoseconds RMS worse than in static mode.

When the antenna is in motion, the roving mode requires enough satellites for a valid navigation fix in order to keep the precision. If the antenna is stationary in roving mode, CT5510 can maintain satisfactory pulse precision with a single visible satellite.

The following sections introduce commands for controlling the one-pulse-per-second (1PPS) timing signal mode.

- **PPSMODE – Set Pulse Per Second mode**

  Activates the One Pulse Per Second (1PPS) operating mode.

  The PPS mode requires precise information about antenna positioning to allow precise timing pulse. Thus CT5510 supports several PPS modes for acquiring the antenna position.

  $PFST,PPSMODE,<mode>

<Mode>	PPS operating mode, may be one one of the following: 0 = PPS mode off. **CT5510** doesn't output PPS pulse. 1 = PPS survey mode. **CT5510** outputs PPS pulse. 2 = PPS static mode. **CT5510** outputs PPS pulse. 3 = PPS roving mode. **CT5510** outputs PPS pulse.

  Examples:
  $PFST,PPSMODE,1<CR><LF>

  Turn on PPS survey mode
  Factory default is <MODE> = 0.

  NOTE: Navigation has to be stopped before giving this command.

  NOTE: To enable PPS mode, the FIXRATE has to be "1".

  NOTE: In order to preserve this setting after reset or power-up, the new setting has to be stored in flash memory by using the $PFST,STORE command.

- **PPSPOS – PPS static mode antenna position**

  Sets the antenna coordinates for PPS static mode. The CT5510 module can't start outputting the PPS signal until the antenna position is defined with this command.

  $PFST,PPSPOS,xxmm.dddd,<N|S>,yyymm.dddd,<E|W>,d.d

xxmm.dddd	Latitude xx = degrees mm = minutes dddd = decimal part of minutes
<N|S>	Either character N or character S, (N = North, S =South)
yyymm.dddd	Longitude yyy = degrees mm = minutes dddd = decimal part of minutes
<E|W>	Either character E or character W, E = East, W = West
d	Altitude, meters from sea level.

  Example:

  $PFST,PPSPOS,6015.2180,N,02208.1813,E,42<CR><LF>

  Sets antenna position to 6015,2180'N, 2208,1813'E, 42 meters above the sea level.

  NOTE: This setting can't be stored in flash memory but has to be given each time after reset or power-up

- **SURVEYLEN – PPS Survey period length**

  Set PPS survey mode averaging period length.

  $PFST,SURVEYLEN,<LEN>

<len>	Survey mode length (number of valid fixes that are averaged during the survey mode).

  Examples:

  $PFST, SURVEYLEN,180<CR><LF>

  Set survey mode length to 180 fixes. Maximum value is 1998780, corresponding to approx. 23 days of continuous satellite visibility.

  Factory default is <LEN> = 28800, corresponding to eight hours of continuous satellite visibility.

NOTE: In order to preserve this setting after reset or power-up, the new setting has to be stored in flash memory by using the $PFST,STORE command.

- **CABLEDEL – Set PPS cable delay**

  Set 1PPS mode cable delay.

  $PFST,CABLEDEL,<DELAY>

< DELAY >	Cable delay in units of 0.01 ns. The cable delay can be either positive or negative in range of approx –21 .. +21 ns.

  Examples:

  $PFST,CABLEDEL,5000

  This command tells CT5510 to output the PPS pulse 50 ns earlier than usual, corresponding to a 10 meters long antenna cable. One meter of antenna cable corresponds roughly to a delay of 5 ns, or –500 units (notice that electromagnetic signal propagates slower in a cable than in void)

  Factory default is <DELAY> = 0.

  NOTE: In order to preserve this setting after reset or power-up, the new setting has to be stored in flash memory by using the $PFST,STORE command.

- **PULSEPOL – Set PPS pulse polarity**

  Set PPS mode's electric pulse polarity.

  $PFST,PULSEPOL,<POL>

< POL >	0 = The PPS signal sets from high to low at PPS pulse 1 = The PPS signal raises from low to high at PPS pulse

  Examples:

  $PFST, PULSEPOL,0

  Factory default is <POL> = 1.

NOTE: In order to preserve this setting after reset or power-up, the new setting has to be stored in flash memory by using the $PFST,STORE command.

- PULSELEN – Set 1PPS pulse length

  Set PPS mode electric pulse length.

  $PFST,PULSELEN,<LEN>

< LEN >	1 PPS pulse length in ms. (range 10 – 900 ms)

  Examples:

  $PFST, PULSELEN,600

  Sets pulse length to 600 ms.

  Factory default is <LEN> = 800.

  NOTE: In order to preserve this setting after reset or power-up, the new setting has to be stored in flash memory by using the $PFST,STORE command.

- **NMEA Message**

  PFST,PPS – PPS signal

  The pulse per second message indicates the parameters of the PPS pulse that will shortly be outputted. It outputs the current GPS time and timing correction term for the upcoming PPS pulse.

  $PFST,PPS,wwww,tttttt,n,xxxx*hh <CR><LF>

wwww	GPS Week (i.e. number of full weeks elapsed since midnight 5-6 January 1980).
tttttt	Time of Week (seconds from the beginning of the current GPS week).
n	Number of satellites used when calculating the solution.
xxxx	Short-time pulse offset of the physical PPS pulse signal (units of 0.01 ns, in range of approx. -15.3 .. 15.3 ns). The correct pulse time can be calculated by subtracting this offset from the physical PPS pulse instant.

  Example:

  $PFST,PPS,1161, 1161,309566,9,495*67