Teltest Electronics

GPS Position Solution Caculations $k := 0..0$ k is the epoch $sv := 0..3$ sv is the satellite $\chi :=$ READPRN(EPHEM11) $\rho :=$ READPRN(PRANGE11) $t_S := \rho_{1,8}$ $t_f := \rho_{1,9} \cdot 10^{-9}$ $tl := t_S + t_f$ $tl = 1.568 \times 10^5$ $SC := -1$

$tsvs_{sv} := \rho_{sv,2}\, s$ $tsvf_{sv} := \rho_{sv,3} \cdot 10^{-9}\, s$ $tsv_{sv} := tsvs_{sv} + tsvf_{sv}$ $xtoc_{sv} := \chi_{sv,6} \cdot K2p4$ $tt_{sv} := tsv_{sv} - (\chi_{sv,6} \cdot K2p4)$ $tsv_{sv} := tsv_{sv} - \left[(\chi_{sv,9} \cdot K2m31) + tt_{sv} \cdot (\chi_{sv,8} \cdot K2m43) + (tt_{sv})^2 \cdot (\chi_{sv,7} \cdot K2m55) \right]$ $toe_{sv} := \chi_{sv,15} \cdot K2p4$

$Mo_{sv} := -\chi_{sv,12} \cdot K\pi 2m31 \cdot rad$ $e_{sv} := \chi_{sv,13} \cdot K2m33$ $A2_{sv} := \chi_{sv,14} \cdot K2m \sqrt{m}$ $\Delta tr_{sv} := F \cdot e_{sv} \cdot A2_{sv} \cdot \sin(Mo_{sv})$ $A_{sv} := (A2_{sv})^2$ $no_{sv} := \sqrt{\frac{\mu}{(A_{sv})^3}}$ $n_{sv} := no_{sv} + (\chi_{sv,11} \cdot K\pi 2m43)$

$t_{sv} := tsv_{sv} - toe_{sv}$ $M_{sv} := Mo_{sv} + (t_{sv} - \Delta tr_{sv}) \cdot n_{sv}$ $E := M$ $\Delta := .1$ $Err_{sv} := \frac{\Delta \cdot (M_{sv} - E_{sv} + e_{sv} \cdot \sin(E_{sv}))}{\Delta + e_{sv} \cdot (\sin(E_{sv}) - \sin(E_{sv} + \Delta))}$ $\Delta_{sv} := \frac{Err_{sv}}{10}$ $E_{sv} := Err_{sv} + E_{sv}$ $Err_{sv} := \frac{\Delta_{sv} \cdot (M_{sv} - E_{sv} + e_{sv} \cdot \sin(E_{sv}))}{\Delta_{sv} + e_{sv} \cdot (\sin(E_{sv}) - \sin(E_{sv} + \Delta_{sv}))}$ $\Delta_{sv} := \frac{Err_{sv}}{10}$ $E_{sv} := Err_{sv} + E_{sv}$

$Err_{sv} := \frac{\Delta_{sv} \cdot (M_{sv} - E_{sv} + e_{sv} \cdot \sin(E_{sv}))}{\Delta_{sv} + e_{sv} \cdot (\sin(E_{sv}) - \sin(E_{sv} + \Delta_{sv}))}$ $E_{sv} := Err_{sv} + E_{sv}$ $Erra_{sv} := E_{sv} - M_{sv} - e_{sv} \cdot \sin(E_{sv})$ $cosE_{sv} := \cos(E_{sv})$ $sinE_{sv} := \sin(E_{sv})$ $\nu_{sv} := \operatorname{atan}\left[\left(\sqrt{\frac{1 + e_{sv}}{1 - e_{sv}}} \cdot \tan\left(\frac{E_{sv}}{2}\right)\right)\right] \cdot 2$ $\Delta tr_{sv} := F \cdot e_{sv} \cdot A2_{sv} \cdot sinE_{sv}$ $tsv_{sv} := tsv_{sv} - \Delta tr_{sv}$

$\Phi_{sv} := \nu_{sv} + -\chi_{sv,18} \cdot K\pi 2m31 \cdot SC$ $sin2\Phi_{sv} := \sin(2 \cdot \Phi_{sv})$ $cos2\Phi_{sv} := \cos(2 \cdot \Phi_{sv})$ $u_{sv} := \Phi_{sv} + (-\chi_{sv,24} \cdot K2m29 \cdot SC \cdot cos2\Phi_{sv} + \chi_{sv,23} \cdot K2m29 \cdot sin2\Phi_{sv})$ $r_{sv} := A_{sv} \cdot (1 - e_{sv} \cdot cosE_{sv}) + (\chi_{sv,22} \cdot K2m5 \cdot cos2\Phi_{sv} + -\chi_{sv,21} \cdot K2m5 \cdot SC \cdot sin2\Phi_{sv})$

$x'_{sv} := r_{sv} \cdot \cos(u_{sv})$ $y'_{sv} := r_{sv} \cdot \sin(u_{sv})$ $i_{sv} := \chi_{sv,17} \cdot K\pi 2m31 + (\chi_{sv,26} \cdot K2m29 \cdot cos2\Phi_{sv} + -\chi_{sv,25} \cdot K2m29 \cdot SC \cdot sin2\Phi_{sv}) + -\chi_{sv,20} \cdot K\pi 2m43 \cdot SC \cdot t_{sv}$ $\Omega_{sv} := \left[-\chi_{sv,16} \cdot K\pi 2m31 \cdot SC + (-\chi_{sv,19} \cdot K\pi 2m43 \cdot SC - \Omega dot_e) \cdot t_{sv}\right] - \Omega dot_e \cdot toe_{sv}$

$cos\Omega_{sv} := \cos(\Omega_{sv})$ $sin\Omega_{sv} := \sin(\Omega_{sv})$ $cosi_{sv} := \cos(i_{sv})$ $sini_{sv} := \sin(i_{sv})$ $x_{sv} := x'_{sv} \cdot cos\Omega_{sv} - y'_{sv} \cdot cosi_{sv} \cdot sin\Omega_{sv}$ $y_{sv} := x'_{sv} \cdot sin\Omega_{sv} + y'_{sv} \cdot cosi_{sv} \cdot cos\Omega_{sv}$ $z_{sv} := y'_{sv} \cdot sini_{sv}$ $range_{sv} := \sqrt{(x_{sv})^2 + (y_{sv})^2 + (z_{sv})^2}$

$x'' := 976932.741$ $y'' := -0 - 5050398.949$ $z'' := 3758625.511$ $\phi'' := 36.3383141667$ $\lambda'' := -79.0521030556$ $h'' := 217.07$

$tpr_{sv} := (tl - tsv_{sv})$ $yi := y \cdot i$ $rs_{sv} := |x_{sv} + yi_{sv}|$ $\theta_{sv} := \arg(x_{sv} + yi_{sv})$ $\phi := \theta - \Omega dot_e \cdot tpr$ $x_{sv} := rs_{sv} \cdot \cos(\phi_{sv})$ $y_{sv} := rs_{sv} \cdot \sin(\phi_{sv})$ Compensation for earth rotation during transmission

Pseudorange Solution $j := 0..3$ $sv := 0..3$ $k := 0$ $j1 := 0..5$ $i := 0..3$ $X_j := x_{j+k}$ $Y_j := y_{j+k}$ $Z_j := z_{j+k}$ Satellite position

$\psi''_{sv} := tpr_{sv} \cdot SOL$ $\psi_j := \psi''_{j+k}$ $x'_r := x''$ $y'_r := y''$ $z'_r := z''$

$x_0 := x'_r$ $y_0 := y'_r$ $z_0 := z'_r$ $c\Delta t_0 := 0$ $\psi'_i := \sqrt{(X_i - x_0)^2 + (Y_i - y_0)^2 + (Z_i - z_0)^2} + c\Delta t_0$ Determine range vectors for approximate position.   Range distances.

$\xi\psi x_i := \frac{-(X_i - x_0)}{\psi'_i}$ $\xi\psi y_i := \frac{-(Y_i - y_0)}{\psi'_i}$ $\xi\psi z_i := \frac{-(Z_i - z_0)}{\psi'_i}$ $M'_{i,0} := \xi\psi x_i$ $M'_{i,1} := \xi\psi y_i$ $M'_{i,2} := \xi\psi z_i$ $M'_{i,3} := 1$ $\delta E := M'^{-1} \cdot (\psi - \psi')$

$$\psi'' = \begin{pmatrix} 2.339 \times 10^7 \\ 2.242 \times 10^7 \\ 2.37 \times 10^7 \\ 2.193 \times 10^7 \end{pmatrix} \qquad \psi = \begin{pmatrix} 2.339 \times 10^7 \\ 2.242 \times 10^7 \\ 2.37 \times 10^7 \\ 2.193 \times 10^7 \end{pmatrix}$$

$$\delta E = \begin{pmatrix} 0.1346 \\ 1.446 \\ 0.1917 \\ -0.8037 \end{pmatrix}$$

$x'' := x_0 + \delta E_0$ $y'' := y_0 + \delta E_1$ $z'' := z_0 + \delta E_2$ $c\Delta t := c\Delta t_0 + \delta E_3$

$x'' = 9.76932875592941 \times 10^5$ $y'' = -5.05039750297842 \times 10^6$ $z'' = 3.7586257 \times 10^6$ $c\Delta t = -0.804$

$e'_x := x'_r - x''$ $e'_y := y'_r - y''$ $e'_z := z'_r - z''$ $Error := \sqrt{(x'_r - x'')^2 + (y'_r - y'')^2 + (z'_r - z''$ $Error = 1.465$

$e'_x = -0.135$ $e'_y = -1.446$ $e'_z = -0.192$

$Ft'Mtr := \frac{1}{.3048}$ $e_2 := \frac{a^2 - b^2}{a^2}$ $e'_2 := \frac{a^2 - b^2}{b^2}$ $p := \sqrt{(x'')^2 + (y'')^2}$ $\theta := \operatorname{atan}\left(\frac{z'' \cdot a}{p \cdot b}\right)$ $\phi := \operatorname{atan}\left(\frac{z'' + e'_2 \cdot b \cdot \sin(\theta)^3}{p - e_2 \cdot a \cdot \cos(\theta)^3}\right)$ $\lambda := \operatorname{atan}\left(\frac{y''}{x''}\right)$ $N := \frac{a^2}{\sqrt{a^2 \cdot \cos(\phi)^2 + b^2 \cdot \sin(\phi)^2}}$ $h := \frac{p}{\cos(\phi)} - N$ $\phi \cdot \frac{180}{\pi} = 36.338323$ $\lambda \cdot \frac{180}{\pi} = -79.052099$

$h = 216.03$ $h \cdot Ft'Mtr = 708.762$

$\left(\phi \cdot \frac{180}{\pi} - \phi''\right) \cdot .3632 \cdot 10^6 \cdot .3048 = 0.978$ $\left(\lambda \cdot \frac{180}{\pi} - \lambda''\right) \cdot .2946 \cdot 10^6 \cdot .3048 = 0.407$ $h - h'' = -1.039$