## $H_{\infty}$ Fault-Tolerant decentralized Observer-Based PID Formation Tracking Design NCS of LEOSs

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## **Appendix**

 $F_{i_1}(t) = -v_{ECI,z_i}\cos\theta_1^i\sin\theta_3^i\dot{\theta}_1^i - \cos\theta_3^i\sin\theta_1^i\dot{\theta}_3^i + \cos\theta_1^i\cos\theta_2^i\cos\theta_3^i\dot{\theta}_2^i - \cos\theta_3^i\sin\theta_1^i\sin\theta_2^i\dot{\theta}_1^i - \cos\theta_1^i\sin\theta_2^i\dot{\theta}_3^i + \cos\theta_3^i\dot{\theta}_3^i - \cos\theta_3^i\sin\theta_2^i\dot{\theta}_3^i - \cos\theta_3^i\sin\theta_3^i\dot{\theta}_3^i - \cos\theta_3^i\cos\theta_3^i\dot{\theta}_3^i - \cos\theta_3^i\cos\theta_3^i\dot{\theta}_3^i - \cos\theta_3^i\cos\theta_3^i\dot{\theta}_3^i - \cos\theta_3^i\cos\theta_3^i\dot{\theta}_3^i - \cos\theta_3^i\cos\theta_3^i\dot{\theta}_3^i - \cos\theta_3^i\cos\theta_3^i\dot{\theta}_3^i\dot{\theta}_3^i - \cos\theta_3^i\dot{\theta}_3^i\dot{\theta}_3^i - \cos\theta_3^i\dot{\theta}_3^i\dot{\theta}_3^i\dot{\theta}_3^i - \cos\theta_3^i\dot{\theta}_3^i\dot{\theta}_3^i\dot{\theta}_3^i - \cos\theta_3^i\dot{\theta}_3^i\dot{\theta}_3^i\dot{\theta}_3^i$  $+\cos\theta_2^i\dot{\theta}_3^i\dot{\theta}_2^i+\cos\theta_3^i\sin\theta_2^iv_{ECI,x_i}\dot{\theta}_2^i+\cos\theta_2^i\sin\theta_3^iv_{ECI,x_i}\dot{\theta}_3^i+\sin\theta_1^i\sin\theta_3^i\dot{v}_{ECI,z_i}-\cos\theta_2^i\cos\theta_3^i\dot{v}_{ECI,x_i}+\cos\theta_1^i\sin\theta_2^iv_{ECI,x_i}\dot{\theta}_3^i+\sin\theta_3^i\dot{v}_{ECI,z_i}-\cos\theta_2^i\cos\theta_3^i\dot{v}_{ECI,x_i}\dot{\theta}_3^i+\cos\theta_2^i\sin\theta_3^iv_{ECI,x_i}\dot{\theta}_3^i+\sin\theta_3^i\dot{v}_{ECI,z_i}\dot{\theta}_3^i+\cos\theta_3^i\sin\theta_3^i\dot{v}_{ECI,x_i}\dot{\theta}_3^i+\cos\theta_3^i\dot{v}_{ECI,x_i}\dot{v}_{ECI,x_i}\dot{\theta}_3^i+\cos\theta_3^i\dot{v}_{ECI,x_i}\dot{v}_{ECI,x_i}\dot{v}_{ECI,x_i}\dot{v}_{ECI,x_i}\dot{v}_{ECI,x_i}\dot{v}_{ECI,x_i}\dot{v}_{ECI,x_i}\dot{v}_{ECI,x_i}\dot{v}_{ECI,x_i}\dot{v}_{ECI,x_i}\dot{v}_{ECI,x_i}\dot{v}_{ECI,x_i}\dot{v}_{ECI,x_i}\dot{v}_{ECI,x_i}\dot{v}_{ECI,x_i}\dot{v}_{ECI,x_i}\dot{v}_{ECI,$  $\times \cos\theta_3^i \dot{v}_{ECI,z_i} + \frac{(J_2^i - J_3^i)}{J_1^i} \left[ -\cos\theta_1^i \sin\theta_1^i \dot{\theta}_2^i \dot{\theta}_2^i + \cos\theta_1^i \cos\theta_2^i \cos\theta_1^i \dot{\theta}_2^i \dot{\theta}_3^i + v_{ECI,x_i} \cos\theta_1^i \sin\theta_2^i \dot{\theta}_2^i + v_{ECI,x_i} \cos\theta_2^i \sin\theta_1^i \dot{\theta}_2^i + v_{ECI,x_i} \cos\theta_2^i \sin\theta_2^i + v_{ECI,x_i} \cos\theta_2^i \sin\theta_2^i + v_{ECI,x_i} \cos\theta_2^i \sin\theta_2^i + v_{ECI,x_i} \cos\theta_2^i \sin\theta_2^i + v_{ECI,x_i} \cos\theta_2^i \cos\theta_2^i + v_{ECI,x_i} \cos\theta_2^i + v_{ECI,x$  $+v_{ECI,x_i}\sin\theta_1^i\cos\theta_2^i\sin\theta_3^i\dot{\theta}_2^i-v_{ECI,x_i}\cos\theta_2^i\cos\theta_2^i\sin\theta_3^i\cos\theta_1^i\dot{\theta}_3^i-v_{ECI,x_i}v_{ECI,x_i}\cos\theta_2^i\sin\theta_3^i\sin\theta_2^i-v_{ECI,x_i}v_{ECI,x_i}\cos\theta_2^i\sin\theta_3^i\sin\theta_2^i-v_{ECI,x_i}\cos\theta_2^i\sin\theta_3^i\cos\theta_2^i\sin\theta_3^i\cos\theta_2^i\sin\theta_3^i\cos\theta_2^i\sin\theta_3^i\cos\theta_2^i\sin\theta_3^i\cos\theta_2^i\sin\theta_3^i\cos\theta_2^i\sin\theta_3^i\cos\theta_2^i\sin\theta_3^i\cos\theta_2^i\sin\theta_3^i\cos\theta_2^i\sin\theta_3^i\cos\theta_2^i\sin\theta_3^i\cos\theta_2^i\cos\theta_2^i\sin\theta_3^i\cos\theta_2^i\cos\theta_2^i\sin\theta_3^i\cos\theta_2^i\cos\theta_2^i\sin\theta_3^i\cos\theta_2^i\cos\theta$  $\times \cos \theta_2^i \sin \theta_3^i \cos \theta_1^i \cos \theta_2^i + \cos \theta_1^i \cos \theta_1^i \cos \theta_2^i v_{ECI,z_i} \dot{\theta}_2^i - \cos \theta_2^i \sin \theta_1^i \sin \theta_1^i \dot{\theta}_2^i \dot{\theta}_3^i + \cos \theta_2^i \cos \theta_2^i \sin \theta_1^i \cos \theta_1^i \dot{\theta}_3^i \dot{\theta}_3^i$  $+v_{ECI,z_i}\cos\theta_2^i\sin\theta_1^i\cos\theta_1^i\cos\theta_2^i\dot{\theta}_3^i-v_{ECI,z_i}\sin\theta_1^i\sin\theta_1^i\cos\theta_3^i\dot{\theta}_2^i-v_{ECI,z_i}\sin\theta_1^i\cos\theta_1^i\sin\theta_2^i\sin\theta_3^i\dot{\theta}_2^i+v_{ECI,z_i}\sin\theta_1^i\cos\theta_3^i\dot{\theta}_2^i-v_{ECI,z_i}\sin\theta_3^i\dot{\theta}_2^i+v_{ECI,z_i}\sin\theta_3^i\dot{\theta}_2^i+v_{ECI,z_i}\sin\theta_3^i\dot{\theta}_3^i+v_{ECI,z_i}\sin\theta$  $\times \cos\theta_1^i \cos\theta_2^i \cos\theta_1^i + v_{ECI,z_i} \cos\theta_1^i \cos\theta_2^i \cos\theta_1^i \sin\theta_2^i \sin\theta_3^i + (v_{ECI,z_i})^2 \times \sin\theta_1^i \cos\theta_3^i \cos\theta_1^i \cos\theta_2^i + (v_{ECI,z_i})^2 \cos\theta_1^i \sin\theta_3^i + (v_{ECI,z_i})^2 \times \sin\theta_1^i \cos\theta_2^i \cos\theta_1^i \cos\theta_2^i \cos\theta_2^i \cos\theta_3^i \cos\theta_$  $\times \cos \theta_1^i \cos \theta_2^i \sin \theta_2^i \sin \theta_3^i$ ];  $F_{i_2}(t) = \frac{1}{\cos\theta_1^i} \left[ -v_{ECI,z_i}\cos\theta_1^i \cos\theta_3^i\dot{\theta}_1^i + \sin\theta_1^i \sin\theta_3^i\dot{\theta}_3^i - \cos\theta_1^i \cos\theta_2^i \sin\theta_3^i\dot{\theta}_2^i - \cos\theta_1^i \cos\theta_3^i \sin\theta_2^i\dot{\theta}_3^i + \sin\theta_1^i \sin\theta_2^i \sin\theta_3^i \right]$  $\times \dot{\theta}_1^i + \sin \theta_1^i \dot{\theta}_2^i \dot{\theta}_1^i - \cos \theta_1^i \cos \theta_2^i \dot{\theta}_3^i \dot{\theta}_1^i + \cos \theta_2^i \cos \theta_3^i v_{ECI, x_i} \dot{\theta}_3^i + \sin \theta_1^i \sin \theta_2^i \dot{\theta}_3^i \dot{\theta}_2^i - \sin \theta_2^i \sin \theta_3^i v_{ECI, x_i} \dot{\theta}_2^i + \cos \theta_2^i \sin \theta_3^i \dot{v}_{ECI, x_i} \dot{\theta}_2^i + \cos \theta_2^i \sin \theta_3^i \dot{\theta}_3^i + \cos \theta_2^i \sin \theta_3^i \dot{\theta}_3^i + \cos \theta_2^i \sin \theta_3^i \dot{\theta}_3^i + \cos \theta_3^i \theta_3^i \dot{\theta}_3^i$  $-\sin\theta_{1}^{i}\cos\theta_{3}^{i}\dot{v}_{ECI,z_{i}}-\cos\theta_{1}^{i}\sin\theta_{2}^{i}\sin\theta_{3}^{i}\dot{v}_{ECI,z_{i}}+\frac{(J_{1}^{i}-J_{3}^{i})}{J_{2}^{i}}\left(-\sin\theta_{1}^{i}\dot{\theta}_{1}^{i}\dot{\theta}_{2}^{i}+\cos\theta_{2}^{i}\cos\theta_{1}^{i}\dot{\theta}_{1}^{i}\dot{\theta}_{3}^{i}+v_{ECI,x_{i}}\sin\theta_{2}^{i}\dot{\theta}_{1}^{i}+v_{ECI,z_{i}}\sin\theta_{2}^{i}\dot{\theta}_{1}^{i}+v_{EC$  $\times\cos\theta_1^i\cos\theta_2^i\dot{\theta}_1^i+\sin\theta_1^i\sin\theta_2^i\dot{\theta}_2^i\dot{\theta}_3^i-\sin\theta_2^i\cos\theta_2^i\cos\theta_1^i\dot{\theta}_3^i\dot{\theta}_3^i-v_{ECI,x_i}\sin\theta_2^i\sin\theta_2^i\dot{\theta}_3^i-v_{ECI,z_i}\sin\theta_2^i\cos\theta_1^i\cos\theta_2^i\dot{\theta}_3^i$  $-v_{ECI,x_i}\sin\theta_1^i\cos\theta_2^i\cos\theta_3^i\dot{\theta}_2^i+v_{ECI,x_i}\cos\theta_1^i\cos\theta_2^i\cos\theta_2^i\cos\theta_3^i+(v_{ECI,x_i})^2\cos\theta_2^i\cos\theta_3^i\sin\theta_2^i+v_{ECI,x_i}v_{ECI,z_i}\cos\theta_2^i$  $\times \cos\theta_3^i \cos\theta_1^i \cos\theta_2^i - v_{ECI,z_i} \sin\theta_1^i \sin\theta_1^i \sin\theta_3^i \dot{\theta}_2^i + v_{ECI,z_i} \sin\theta_1^i \sin\theta_3^i \cos\theta_2^i \cos\theta_1^i \dot{\theta}_3^i + v_{ECI,x_i} v_{ECI,z_i} \sin\theta_1^i \sin\theta_3^i \sin\theta_3^i \cos\theta_2^i \cos\theta_2^i \cos\theta_3^i \dot{\theta}_3^i + v_{ECI,z_i} \sin\theta_3^i \sin\theta_3^i \sin\theta_3^i \sin\theta_3^i \cos\theta_3^i \cos$  $+ (v_{ECI,z_i})^2 \sin \theta_1^i \sin \theta_3^i \cos \theta_1^i \cos \theta_2^i + v_{ECI,z_i} \cos \theta_1^i \sin \theta_1^i \sin \theta_2^i \cos \theta_3^i \dot{\theta}_2^i - v_{ECI,z_i} \cos \theta_1^i \sin \theta_2^i \cos \theta_3^i \cos \theta_1^i \cos \theta_2^i$  $-v_{ECI,x_i}v_{ECI,z_i}\cos\theta_1^i\sin\theta_2^i\cos\theta_3^i\sin\theta_2^i-(v_{ECI,z_i})^2\cos\theta_1^i\cos\theta_1^i\cos\theta_2^i\sin\theta_2^i\cos\theta_3^i)];$  $F_{i_3}(t) = \frac{1}{\cos\theta_1^i\cos\theta_2^i} \left[\cos\theta_1^i\dot{\theta}_1^i\dot{\theta}_2^i - \cos\theta_2^i v_{ECI,x_i}\dot{\theta}_2^i + \cos\theta_2^i\sin\theta_1^i\dot{\theta}_1^i\dot{\theta}_3^i + \cos\theta_1^i\sin\theta_2^i\dot{\theta}_2^i\dot{\theta}_3^i + \cos\theta_2^i\sin\theta_1^i v_{ECI,z_i}\dot{\theta}_1^i + \cos\theta_1^i\sin\theta_2^i\dot{\theta}_2^i\dot{\theta}_3^i + \cos\theta_2^i\sin\theta_2^i\dot{\theta}_2^i\dot{\theta}_3^i + \cos\theta_2^i\sin\theta_2^i\dot{\theta}_3^i\dot{\theta}_3^i + \cos\theta_2^i\sin\theta_2^i\dot{\theta}_3^i\dot{\theta}_3^i\dot{\theta}_3^i + \cos\theta_2^i\sin\theta_2^i\dot{\theta}_3^i\dot{\theta}_3^i + \cos\theta_2^i\sin\theta_2^i\dot{\theta}_3^i\dot{\theta}_3^i\dot{\theta}_3^i + \cos\theta_2^i\sin\theta_2^i\dot{\theta}_3^i\dot{\theta}_3^i + \cos\theta_2^i\sin\theta_2^i\dot{\theta}_3^i\dot{\theta}_3^i + \cos\theta_2^i\sin\theta_2^i\dot{\theta}_3^i\dot{\theta}_3^i + \cos\theta_2^i\sin\theta_2^i\dot{\theta}_3^i\dot{\theta}_3^i\dot{\theta}_3^i + \cos\theta_2^i\sin\theta_2^i\dot{\theta}_3^i\dot{\theta}$  $\times \sin \theta_{2}^{i} v_{ECI,z_{i}} \dot{\theta}_{2}^{i} + \sin \theta_{2}^{i} \dot{v}_{ECI,x_{i}} + \cos \theta_{1}^{i} \cos \theta_{2}^{i} \dot{v}_{ECI,z_{i}} + \frac{(J_{2}^{i} - J_{1}^{i})}{J_{2}^{i}} (\cos \theta_{1}^{i} \dot{\theta}_{1}^{i} \dot{\theta}_{2}^{i} + \cos \theta_{2}^{i} \sin \theta_{1}^{i} - v_{ECI,x_{i}} \cos \theta_{2}^{i} \sin \theta_{3}^{i} \dot{\theta}_{1}^{i})$  $+v_{ECI,z_i}\sin\theta_1^i\cos\theta_3^i\dot{\theta}_1^i+v_{ECI,z_i}\cos\theta_1^i\sin\theta_2^i\sin\theta_2^i\sin\theta_2^i\dot{\theta}_1^i-\sin\theta_2^i\cos\theta_1^i\dot{\theta}_2^i\dot{\theta}_3^i-\sin\theta_2^i\sin\theta_1^i\cos\theta_2^i\dot{\theta}_3^i\dot{\theta}_3^i+v_{ECI,x_i}\sin\theta_2^i\cos\theta_2^i\dot{\theta}_3^i\dot{\theta}_3^i+v_{ECI,x_i}\sin\theta_2^i\cos\theta_2^i\dot{\theta}_3^i\dot{\theta}_3^i+v_{ECI,x_i}\sin\theta_2^i\cos\theta_2^i\dot{\theta}_3^i\dot{\theta}_3^i+v_{ECI,x_i}\sin\theta_2^i\cos\theta_2^i\dot{\theta}_3^i\dot{\theta}_3^i+v_{ECI,x_i}\sin\theta_2^i\cos\theta_2^i\dot{\theta}_3^i\dot{\theta}_3^i+v_{ECI,x_i}\sin\theta_2^i\cos\theta_2^i\dot{\theta}_3^i\dot{\theta}_3^i+v_{ECI,x_i}\sin\theta_2^i\cos\theta_2^i\dot{\theta}_3^i\dot{\theta}_3^i+v_{ECI,x_i}\sin\theta_2^i\cos\theta_2^i\dot{\theta}_3^i\dot{\theta}_3^i+v_{ECI,x_i}\sin\theta_2^i\cos\theta_2^i\dot{\theta}_3^i\dot{\theta}_3^i+v_{ECI,x_i}\sin\theta_2^i\cos\theta_2^i\dot{\theta}_3^i\dot{\theta}_3^i+v_{ECI,x_i}\sin\theta_2^i\cos\theta_2^i\dot{\theta}_3^i\dot{\theta}_3^i+v_{ECI,x_i}\sin\theta_2^i\cos\theta_2^i\dot{\theta}_3^i\dot{\theta}_3^i+v_{ECI,x_i}\sin\theta_2^i\cos\theta_2^i\dot{\theta}_3^i\dot{\theta}_3^i+v_{ECI,x_i}\sin\theta_2^i\cos\theta_2^i\dot{\theta}_3^i\dot{\theta}_3^i+v_{ECI,x_i}\sin\theta_2^i\cos\theta_2^i\dot{\theta}_3^i\dot{\theta}_3^i+v_{ECI,x_i}\sin\theta_2^i\cos\theta_2^i\dot{\theta}_3^i\dot{\theta}_3^i+v_{ECI,x_i}\sin\theta_2^i\cos\theta_2^i\dot{\theta}_3^i\dot{\theta}_3^i+v_{ECI,x_i}\sin\theta_2^i\cos\theta_2^i\dot{\theta}_3^i\dot{\theta}_3^i+v_{ECI,x_i}\sin\theta_2^i\cos\theta_2^i\dot{\theta}_3^i\dot{\theta}_3^i+v_{ECI,x_i}\sin\theta_2^i\cos\theta_2^i\dot{\theta}_3^i\dot{\theta}_3^i+v_{ECI,x_i}\sin\theta_2^i\cos\theta_2^i\dot{\theta}_3^i\dot{\theta}_3^i+v_{ECI,x_i}\sin\theta_2^i\cos\theta_2^i\dot{\theta}_3^i\dot{\theta}_3^i+v_{ECI,x_i}\sin\theta_2^i\cos\theta_2^i\dot{\theta}_3^i\dot{\theta}_3^i+v_{ECI,x_i}\sin\theta_2^i\cos\theta_2^i\dot{\theta}_3^i\dot{\theta}_3^i+v_{ECI,x_i}\sin\theta_2^i\cos\theta_2^i\dot{\theta}_3^i\dot{\theta}_3^i+v_{ECI,x_i}\sin\theta_2^i\cos\theta_2^i\dot{\theta}_3^i\dot{\theta}_3^i+v_{ECI,x_i}\sin\theta_2^i\cos\theta_2^i\dot{\theta}_3^i\dot{\theta}_3^i+v_{ECI,x_i}\sin\theta_2^i\cos\theta_2^i\dot{\theta}_3^i\dot{\theta}_3^i+v_{ECI,x_i}\sin\theta_2^i\cos\theta_2^i\dot{\theta}_3^i\dot{\theta}_3^i+v_{ECI,x_i}\sin\theta_2^i\cos\theta_2^i\dot{\theta}_3^i\dot{\theta}_3^i+v_{ECI,x_i}\sin\theta_2^i\cos\theta_2^i\dot{\theta}_3^i\dot{\theta}_3^i+v_{ECI,x_i}\sin\theta_2^i\cos\theta_2^i\dot{\theta}_3^i\dot{\theta}_3^i+v_{ECI,x_i}\sin\theta_2^i\cos\theta_2^i\dot{\theta}_3^i\dot{\theta}_3^i+v_{ECI,x_i}\sin\theta_2^i\cos\theta_2^i\dot{\theta}_3^i\dot{\theta}_3^i+v_{ECI,x_i}\sin\theta_2^i\cos\theta_2^i\dot{\theta}_3^i\dot{\theta}_3^i\dot{\theta}_3^i+v_{ECI,x_i}\sin\theta_2^i\cos\theta_2^i\dot{\theta}_3^i\dot{\theta}_3^i\dot{\theta}_3^i+v_{ECI,x_i}\sin\theta_2^i\cos\theta_2^i\dot{\theta}_3^i\dot{\theta}_3^i+v_{ECI,x_i}\sin\theta_2^i\cos\theta_2^i\dot{\theta}_3^i\dot{\theta}_3^i+v_{ECI,x_i}\sin\theta_2^i\dot{\theta}_3^i\dot{\theta}_3^i+v_{ECI,x_i}\sin\theta_2^i\dot{\theta}_3^i\dot{\theta}_3^i+v_{ECI,x_i}\sin\theta_2^i\dot{\theta}_3^i\dot{\theta}_3^i+v_{ECI,x_i}\sin\theta_2^i\dot{\theta}_3^i\dot{\theta}_3^i+v_{ECI,x_i}\sin\theta_2^i\dot{\theta}_3^i\dot{\theta}_3^i+v_{ECI,x_i}\sin\theta_2^i\dot{\theta}_3^i+v_{ECI,x_i}\sin\theta_2^i\dot{\theta}_3^i\dot{\theta}_3^i+v_{ECI,x_i}\sin\theta_2^i\dot{\theta}_3^i\dot{\theta}_3^i+v_{ECI,x_i}\sin\theta_2^i\dot{\theta}_3^i\dot{\theta}_3^i+v_{ECI,x_i}\sin\theta_2^i\dot{\theta}_3^i+v_{ECI,x_i}\sin\theta_2^i\dot{\theta}_3^i+v_{ECI,x_i}\sin\theta_2^i$  $\times \sin\theta_3^i \dot{\theta}_3^i - v_{ECI,z_i} \sin\theta_1^i \cos\theta_3^i \sin\theta_2^i \dot{\theta}_3^i - v_{ECI,z_i} \cos\theta_1^i \sin\theta_2^i \sin\theta_3^i \sin\theta_2^i \dot{\theta}_3^i + v_{ECI,x_i} \cos\theta_2^i \cos\theta_3^i \cos\theta_1^i \dot{\theta}_2^i + v_{ECI,x_i} \cos\theta_2^i \cos\theta_3^i \cos\theta_3^i \cos\theta_2^i \cos\theta_3^i \cos\theta_3$  $\times \cos \theta_2^i \cos \theta_3^i \cos \theta_2^i \sin \theta_1^i \dot{\theta}_3^i - (v_{ECI,x_i})^2 \cos \theta_2^i \cos \theta_3^i \cos \theta_3^i + v_{ECI,x_i} v_{ECI,z_i} \cos \theta_2^i \sin \theta_1^i \cos \theta_3^i \cos \theta_3^i + v_{ECI,x_i} v_{ECI,x_i} \cos \theta_2^i \sin \theta_3^i \cos \theta$  $\times v_{ECI,z_i}\cos\theta_2^i\cos\theta_3^i\cos\theta_1^i\sin\theta_2^i\sin\theta_3^i - v_{ECI,z_i}\sin\theta_1^i\sin\theta_3^i\cos\theta_1^i\dot{\theta}_2^i - v_{ECI,z_i}\cos\theta_1^i\sin\theta_2^i\cos\theta_3^i\cos\theta_2^i\sin\theta_1^i\dot{\theta}_3^i$  $+v_{ECI,x_i}v_{ECI,z_i}\cos\theta_1^i\sin\theta_2^i\cos\theta_3^i\cos\theta_2^i\sin\theta_3^i - (v_{ECI,z_i})^2\cos\theta_1^i\sin\theta_2^i\cos\theta_3^i\sin\theta_1^i\cos\theta_3^i - (v_{ECI,z_i})^2\cos\theta_1^i\sin\theta_2^i\cos\theta_3^i - (v_{ECI,z_i})^2\cos\theta_1^i\sin\theta_2^i\cos\theta_3^i - (v_{ECI,z_i})^2\cos\theta_1^i\sin\theta_2^i\cos\theta_3^i - (v_{ECI,z_i})^2\cos\theta_3^i\sin\theta_2^i\cos\theta_3^i - (v_{ECI,z_i})^2\cos\theta_3^i\sin\theta_3^i - (v_{ECI,z_i})^2\cos\theta_3^i\cos\theta_3^i\cos\theta_3^i - (v_{ECI,z_i})^2\cos\theta_3^i\cos\theta_3^$  $\times \cos \theta_3^i \cos \theta_1^i \sin \theta_2^i \sin \theta_3^i$ ];