

PRODUCTION PLANE ORIGIN AND ORIENTATION

Inputs: P_x', P_y', P_z' , λ_p', ζ_p' , X, Y, Z

Block: Coordinate transformation (Earth to production plane)

Output: X_p', Y_p', Z_p'

PRODUCTION PLANE COORDINATES

Inputs: X_p', Y_p', Z_p'

Block: Vertical bar representing the production plane

Outputs: $X_p (m)$, $Y_p (m)$

PRODUCTION PLANE RADIUS SET POINT

Input: $R_{SP} (m)$

Block: Summing junction (+, -)

Block: PI controller (P: 0.01, I: 0.02)

Block: Low-pass filter ($\frac{0.1}{s + 0.1}$)

Block: Summing junction (+, -)

Block: PI controller (P: 0.005, I: 0.008)

Block: PI controller (P: -0.04, I: -0.006)

INNER LOOP

ANGLE OF ATTACK SET POINT

$\alpha_{SP} (deg)$ enters a summing junction (+). The output is $\alpha (deg)$, which is fed back to the same summing junction. The output of the summing junction enters a PI controller (P: -0.2, I: -0.6). The output of the PI controller enters another summing junction (+). The output of this second summing junction is $\delta_{e_{SP}} (deg)$, which is the **ELEVATOR** command. $\delta_e > 0$: nose down.

θ enters a $\sin$ block, followed by a gain block K_g . The output of K_g is added to the output of the PI controller at the second summing junction. This path is labeled α -oscillation suppression.

SIDSLIP ANGLE SET POINT

$\beta_{SP} (deg)$ enters a summing junction (+). The output is $\beta (deg)$, which is fed back to the same summing junction. The output of the summing junction enters a PI controller (P: 0.5, I: 0.5). The output of the PI controller is $\delta_{r_{SP}} (deg)$, which is the **RUDDER** command. $\delta_r > 0$: left rudder.

REFERENCE PLANE ROLL ANGLE SET POINT

$\varphi_{R_{SP}} (deg)$ enters a summing junction (+). The output is $\varphi_R (deg)$, which is fed back to the same summing junction. The output of the summing junction enters a PI controller (P: -0.5, I: -0.5). The output of the PI controller enters another summing junction (+). The output of this second summing junction is $\delta_{a_{SP}} (deg)$, which is the **AILERON** command. $\delta_a > 0$: left roll.

Coordinate transformation (Earth to reference plane)

Inputs: λ_R , ζ_R , and φ, θ, ψ (labeled **EARTH-AXIS EULER ANGLES**). Output: $\varphi_{R'}, \theta_{R'}, \psi_R$ (labeled **REFERENCE PLANE EULER ANGLES**).

Roll Stability Augmentation

$\theta_R (deg)$ (from the reference plane Euler angles) enters a gain block K_r (labeled -0.5). The output of K_r is added to the output of the PI controller at the second summing junction for the aileron loop. This path is labeled K_r Lean-out roll stability augmentation.