Eq 1

__inner PD__

2 free integrators

Type = 2

$$m_{\alpha i} = \lim_{s \to 0} (PC) s^2 = \lim_{s \to 0} s^2 \frac{(K_{pi} + s K_0) 2.65}{s^2} =$$

$$= K_{pi} 2.65$$

__step__

$$\lim_{t \to \infty} e(t) = 0$$

__Ramp__

$$\lim_{t \to \infty} e(t) = 0$$

__Parabola__

$$\lim_{t \to \infty} (e(t)) = \frac{1}{K_{pi} 2.65}$$

__for input disturbance__

$$E_{Din} = \frac{P}{1 + PC} D_{in} = \frac{2.65/s^2}{1 + \frac{(K_{pi} + s K_0) 2.65}{s^2}} D_{in}$$

$$E_{Din} = \frac{2.65}{s^2 + 2.65 K_{pi} + s K_0 2.65}$$ 0 free integrators

Type = 0

2 free integrators __Outer PD__

$$m_{\alpha o} = \lim_{s \to 0} s^2 \frac{(K_{po} + s K_0) 2.65}{s^2}$$

Type = 2

$$= K_{po} 2.65$$

	__Step__	__Ramp__	__Parabola__
w/o D int	0	0	$\frac{1}{K_{po} 9.81}$
w/ int	0	0	0

3 free integrators

for D_{in} free integrators in the plant dont matter thus

PD   Type = 0

PID   Type = 1

By Observation

[F9] Longitudinal

PD Type: 2   PID Type: 3

sse step: 0   sse step: 0   PD D_{in} Type:

sse Ramp: 0   sse Ramp: 0   PID D_{in} Type:

sse Par: $\frac{M}{K_p}$ sse Par: 0

$$M_a = \lim_{s \to 0} \cancel{s} \frac{K_p + s K_D}{\cancel{s} M} = \frac{K_p}{M}$$

Lateral inner

PD Type: 2   sse step: 0   sse Ramp: 0   sse Par: $\frac{K_p}{J}$

$$M_a = \cancel{s} \frac{1}{J \cancel{s}} (K_p + s K_D) = \frac{K_p}{J} \qquad D_{in} \text{ Type: } 0$$

Lateral outer

PD Type: 1   sse step: 0   sse Ramp: $\frac{M}{F_c K_p}$ sse Par: ∞

PID Type: 2   sse step: 0   sse Ramp: 0   sse Par: $\frac{M}{F_c K_i}$

D_{in} PD Type: 0   PID Type: 1

$$M_r = \lim_{s \to 0} \cancel{s} \frac{F_c}{\cancel{s}(M + sM)} (K_p + s K_D) = \frac{F_c K_p}{M}$$

$$M_a = \lim_{s \to 0} \cancel{s} \frac{F_c}{\cancel{s}(M + sM)} \left(K_p s + s^2 K_D + K_i \right) \frac{1}{s} = \frac{F_c K_i}{M}$$