

14/03/2019

Basic block for all our control schemes

PID inc/dec locks positional

2dof Freeze mode

AW max/min override

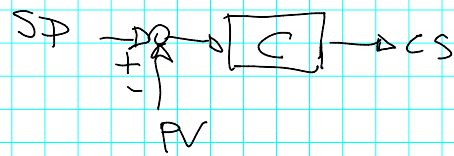
tracking bias

DIGITAL Fixed rate

2IE or BD method

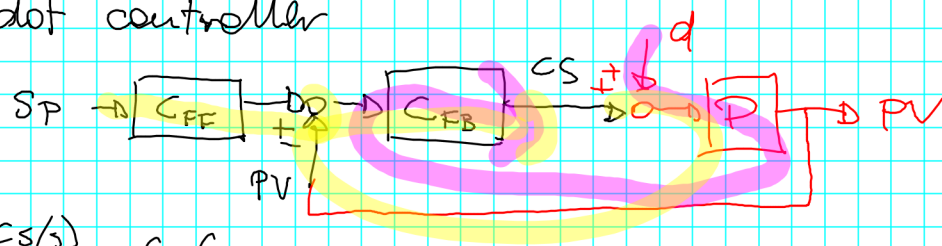
• P control : $csp = K(b \cdot sp - pv)$

↑ 1-dof controller



$$\frac{CS(s)}{SP(s)} = - \frac{CS(s)}{PV(s)}$$

3 dof controller




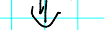
$$\frac{CS(s)}{SP(s)} = C_{FF}C_{FB}$$


$$\frac{CS(s)}{PV(s)} = -C_{FB}$$



$C_{FB} \rightarrow$ stability & d. rejection
 $C_{FF} \rightarrow$ SP tracking

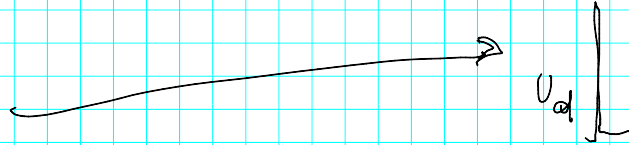
4 PID case

$$CS = K \left(b \underset{\uparrow}{SP - PV} + \frac{1}{sT_i} (SP - PV) + \frac{sT_d}{1 + sT_d/\lambda} \underset{\uparrow}{(cSP - PV)} \right)$$

SP  PV 

e 

 $U_P =$ 



Same PID's Fix $c \rightarrow 0$
output-denied PID

1 control

$$U_i(s) = \frac{K}{sT_i} (sp(s) - pv(s))$$

$$\uparrow \frac{z-1}{zT_s} \quad \Delta := 1 - z^{-1}$$

$$\Delta v(k) = v(k) - v(k-1)$$

$$\Delta V(z) = (1 - z^{-1}) V(z)$$

$$\Rightarrow U_i = \frac{KT_s}{\Delta T_i} (sp - pv) \Rightarrow \Delta U_i = \frac{KT_s}{T_i} (sp - pv)$$

• D control

$$U_d = \frac{\cancel{K} T_d}{1 + s T_d / N} (c s p - p v) \quad \left(\frac{z-1}{z^{-1} T_s} \right)$$

$$= \frac{K T_d / T_s}{1 + \frac{z-1}{z^{-1} T_s} \frac{T_d}{N}} (c \Delta s p - \Delta p v) =$$

$$= \frac{\cancel{z} \cancel{T_s} N \cancel{K} \cancel{T_d} / \cancel{T_s}}{z^{-1} T_s N + z T_d - T_d} (||) = \frac{z N K T_d / T_d + N T_s}{z - \frac{T_d}{T_d + N T_s}} (c \Delta s p - \Delta p v)$$

$$U_d \frac{z^{NKT_d} / T_d + NT_s}{z - \frac{T_d}{T_d + NT_s}} (c\Delta sp - \Delta pv)$$

$$U_d(k) = \frac{T_d}{T_d + NT_s} U_d(k-1) + \frac{NKT_d}{T_d + NT_s} (c\Delta sp(k) - \Delta pv(k))$$

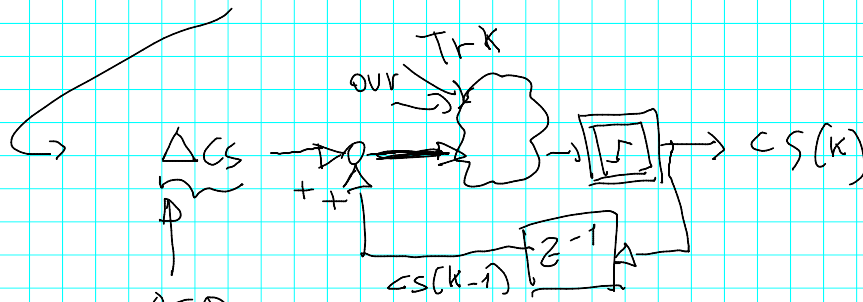
8 Positional

SP
PV \rightarrow CS

.

Incremental SP $\rightarrow \Delta CS \rightarrow CS = CS_{old} + \Delta CS$
i

Positional vs. incremental



ΔSP
 ΔPV

~~only~~ For example $\Delta CS_p = K(b \Delta SP - \Delta PV)$



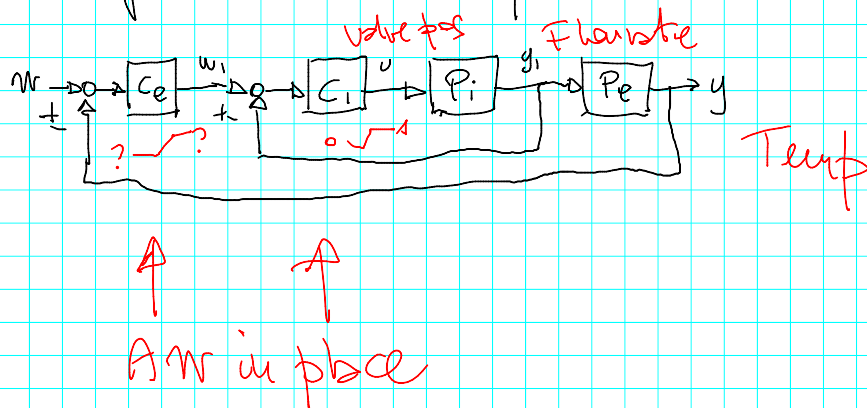
$$\Delta CSI = \frac{kT_s}{T_i} (SP - PV)$$

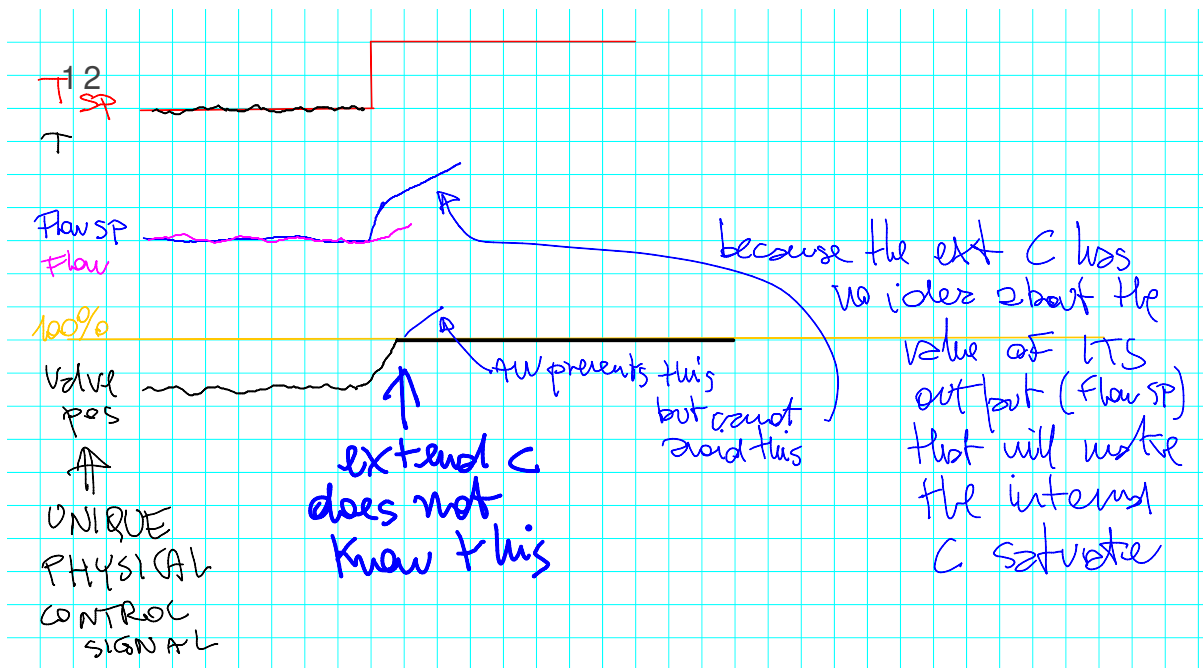
without 1 action
this is best

$$\text{But } \Delta CS\phi = k(b\Delta SP - \Delta PV)$$

1 inc/dec locks

One major reason is windup in cascade loops





Solution: When internal controller saturates
ext controller must be pushed into saturation
further push it into saturation

