Lambda (IMC) Tuning for PI Controllers

PI controller gain and integral time by lambda tuning for a self-regulating first-order plus dead-time process, from the closed-loop time constant λ.

Method: Lambda tuning (Dahlin 1968; IMC, Rivera, Morari and Skogestad 1986)

Input parameters

Unit system: SI

Parameter	Value	Unit
Process gain (change in output / change in controller output)	2.0000	
Process time constant	60.000	s
Dead time	10.000	s
Closed-loop time constant λ Often 1 to 3 times the process time constant; larger is more robust.	90.000	s

Calculated results

Parameter	Value	Unit
Controller gain	0.30000	
Integral time (= τ)	60.000	s
Speed ratio λ/τ (1 = same speed as open loop)	1.5000	

Notes for this case

- No overshoot to a set-point step when the model is right; choose λ to coordinate interacting loops.

Formula and method

$$K_c = \frac{\tau}{K_p(\lambda + \theta)}, \quad T_i = \tau$$

Variables

K_p	Process gain (change in output / change in controller output)	-
τ	Process time constant	s
θ	Dead time	s
λ	Closed-loop time constant λ	s
K_c	Controller gain	-
T_i	Integral time (= τ)	s
λ/τ	Speed ratio λ/τ (1 = same speed as open loop)	-

Method and standards

Internal model control design.

Assumptions and limits

- First-order plus dead time.

References

- Lambda tuning (Dahlin 1968; IMC, Rivera, Morari and Skogestad 1986)

Report details

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Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/instrumentation/control-loops/lambda-tuning

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.