PID Tuning by Ziegler–Nichols (Ultimate Gain)

Starting P, PI and PID controller settings from the ultimate gain and ultimate period found in a closed-loop test, by the Ziegler–Nichols rules.

Method: J.G. Ziegler and N.B. Nichols (1942)

Input parameters

Unit system: SI

Parameter	Value	Unit
Ultimate gain (gain at steady oscillation)	4.0000	
Ultimate period of the oscillation	60.000	s

Calculated results

Parameter	Value	Unit
PID: proportional gain	2.4000	
PID: integral time	30.000	s
PID: derivative time	7.5000	s
PI: proportional gain	1.8000	
PI: integral time	50.000	s
P only: proportional gain	2.0000	

Notes for this case

• Ziegler–Nichols settings are aggressive (quarter-amplitude decay); reduce the gain for smoother boiler loops. Gain here is dimensionless (% output per % input); convert from proportional band if your controller uses it.

Formula and method

$$P: K_p = 0.5K_u \qquad PI: K_p = 0.45K_u,\ T_i = T_u/1.2 \qquad PID: K_p = 0.6K_u,\ T_i = T_u/2,\ T_d = T_u/8$$

Variables

K_u	ultimate gain	–
T_u	ultimate period	s
$K_{p,PID}$	PID gain	–
$T_{i,PID}$	PID integral time	s
$T_{d,PID}$	PID derivative time	s
$K_{p,PI}$	PI gain	–
$T_{i,PI}$	PI integral time	s
$K_{p,P}$	P-only gain	–
K_p, T_i, T_d	gain, integral and derivative time in general	–, s, s

Method and standards

Ziegler and Nichols (1942) closed-loop (ultimate sensitivity) rules for an ideal (standard) PID form.

Assumptions and limits

- Ideal PID form; linear process near the operating point.

References

• J.G. Ziegler and N.B. Nichols (1942)

Report details

Report reference	FCC-Y84C-N9V9 (the same inputs always give the same reference)
Generated	17 November 2026, 19:46 UTC
Calculator	PID Tuning by Ziegler–Nichols (Ultimate Gain)
Method last reviewed	11 November 2026
Software release	FireCAD Calc, release of 17 November 2026
Release checks	3 reference cases of this calculator, computed independently, are checked on every release

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/pid-tuning-ziegler-nichols

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.