Step Test Model: Gain, Time Constant and Dead Time (Two-Point Method)

Process gain, time constant and dead time of a first-order plus dead-time model from a step test by Smith's two-point method (28.3 % and 63.2 % times).

Method: C.L. Smith; Digital Computer Process Control (1972); ...

Input parameters

Unit system: SI

Parameter	Value	Unit
Step in controller output	10.000	
Final change in the measured variable	20.000	
Time to 28.3 % of the change (from the step)	30.000	s
Time to 63.2 % of the change	70.000	s

Calculated results

Parameter	Value	Unit
Process gain Δy / Δu	2.0000	
Time constant 1.5 (t_{63} − t_{28})	60.000	s
Dead time t_{63} − τ	10.000	s
Controllability ratio θ/τ	0.16667	

Notes for this case

- Express Δu and Δy in the same units (usually % of range) so the gain is dimensionless.

Formula and method

$$\tau = 1.5\,(t_{63} - t_{28}), \quad \theta = t_{63} - \tau, \quad K_p = \frac{\Delta y}{\Delta u}$$

Variables

Δu	Step in controller output	-
Δy	Final change in the measured variable	-
t_{28}	Time to 28.3 % of the change (from the step)	s
t_{63}	Time to 63.2 % of the change	s
K_p	Process gain Δy / Δu	-
τ	Time constant 1.5 (t_{63} − t_{28})	s
θ	Dead time t_{63} − τ	s
θ/τ	Controllability ratio θ/τ	-

Method and standards

Two points on the first-order step response.

Assumptions and limits

- Self-regulating response.

References

- C.L. Smith
- Digital Computer Process Control (1972)
- two-point method

Report details

Report reference	FCC-9FSB-AS5S (the same inputs always give the same reference)
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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/fopdt-two-point-identification

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.