Power System Inertia and Rate of Change of Frequency (RoCoF)

Stored rotating energy, initial rate of change of frequency after losing generation and the time to reach a frequency limit without response, from system inertia.

Method: Aggregate swing equation of a power system

Input parameters

Unit system: SI

Parameter	Value	Unit
Rating of synchronous machines online	30,000	MVA
Average inertia constant	4.0000	s
Generation lost	1,320.0	MW
Nominal frequency	50.000	Hz
Frequency deviation limit (for the time)	0.80000	Hz

Calculated results

Parameter	Value	Unit
Stored kinetic energy	120.00	GJ
Initial rate of change of frequency (Hz/s)	0.27500	
Time to reach the deviation limit without response	2.9091	s
Inertia constant needed to keep RoCoF at 1 Hz/s	1.1000	s

Notes for this case

• Swing equation for the whole system right after the loss: df/dt = ΔP f_0/(2HS). Wind, solar and batteries behind inverters add no inertia unless they provide synthetic inertia, so RoCoF rises as they displace synchronous machines; load damping and governor response then arrest the fall.

Formula and method

$$E_k = HS, \quad \frac{df}{dt} = \frac{\Delta P f_0}{2HS}$$

Variables

S	Rating of synchronous machines online	VA
H	Average inertia constant	s
ΔP	Generation lost	W
f_0	Nominal frequency	1/s
Δf	Frequency deviation limit (for the time)	1/s
E_k	Stored kinetic energy	J
df/dt	Initial rate of change of frequency (Hz/s)	-
t	Time to reach the deviation limit without response	s
H_{min}	Inertia constant needed to keep RoCoF at 1 Hz/s	s

Method and standards

System inertia.

Assumptions and limits

- Single-area system; first instant after the loss.

References

Aggregate swing equation of a power system

Report details

Report reference	FCC-YBZT-P5MX (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/electrical/power/grid-inertia-rocof

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.