Capacitor Bank Switching Inrush Current and Frequency

Peak inrush current and frequency when energising an isolated capacitor bank, and back-to-back when another bank is already on through a small inductance.

Method: Capacitor switching transients

Input parameters

Unit system: SI

Parameter	Value	Unit
System voltage (line-to-line)	11.000	kV
Frequency	50.000	Hz
Bank being switched	3.0000	Mvar
Short-circuit level at the bank	250.00	MVA
Bank already energised (0 if none)	3.0000	Mvar
Inductance between the banks	20.000	µH

Calculated results

Parameter	Value	Unit
Rated bank current	157.46	A
Peak inrush, isolated bank	2.0328	kA
Inrush frequency, isolated bank	456.44	Hz
Peak inrush, back-to-back	12.616	kA
Inrush frequency, back-to-back	5.6654	kHz

Notes for this case

• Isolated: Î = √2·I_r√(S_sc/Q), f = f₀√(S_sc/Q). Back-to-back: Î = √(2/3)·V√(C_eq/L_b) with star-equivalent capacitances in series, limited only by the bus and cable inductance between banks; current-limiting reactors keep it within switchgear and capacitor ratings.

Formula and method

$$\widehat{I_{iso}} = \sqrt{2}\, I_r \sqrt{\frac{S_{sc}}{Q}},\quad \widehat{I_{b2b}} = \sqrt{\frac{2}{3}}\, V \sqrt{\frac{C_{eq}}{L_b}},\quad f_{b2b} = \frac{1}{2\pi\sqrt{L_b C_{eq}}}$$

Variables

V	System voltage (line-to-line)	V
f	Frequency	1/s
Q_1	Bank being switched	var
S_{sc}	Short-circuit level at the bank	VA
Q_2	Bank already energised (0 if none)	var
L_b	Inductance between the banks	H
I_r	Rated bank current	A
$\widehat{I_{iso}}$	Peak inrush, isolated bank	A
f_{iso}	Inrush frequency, isolated bank	1/s
$\widehat{I_{b2b}}$	Peak inrush, back-to-back	A
f_{b2b}	Inrush frequency, back-to-back	1/s

Method and standards

Switching transients.

Assumptions and limits

- Lossless circuit; switching at voltage peak (worst case).

References

Capacitor switching transients

Report details

Report reference	FCC-Y45T-NJBM (the same inputs always give the same reference)
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Calculator	Capacitor Bank Switching Inrush Current and Frequency
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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-quality/capacitor-bank-switching-inrush

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.