Detuned Capacitor Bank: Reactor Size and Tuning Frequency

Series reactor for a detuned capacitor bank from the detuning factor p, the resulting tuning frequency and order, the effective kvar and the capacitor voltage rise.

Method: Series LC detuning: n_r = 1/√p; V_cap = V/(1 − p) (power factor correction practice)

Input parameters

Unit system: SI

Parameter	Value	Unit
Capacitor rating at its rated voltage	100.00	kvar
Capacitor rated voltage	480.00	V
System voltage	415.00	V
Detuning factor X_L/X_C	7.0000	%
System frequency	50.000	Hz

Calculated results

Parameter	Value	Unit
Capacitor reactance per phase (star)	2.3040	Ω
Reactor reactance	0.16128	Ω
Reactor inductance	0.51337	mH
Tuning frequency	188.98	Hz
Tuning order	3.7796	
Effective output at system voltage	80.377	kvar
Voltage across the capacitor	446.24	V

Notes for this case

- p = 7 % tunes to about 189 Hz (order 3.78) at 50 Hz, below the 5th harmonic; 14 % (order 2.67) where 3rd harmonics are significant. Capacitors must be rated for the raised voltage V_s/(1 − p).

Formula and method

$$X_L = pX_C, \quad n_r = \frac{1}{\sqrt{p}}, \quad Q_{eff} = \frac{V_s^2}{X_C - X_L}, \quad V_{cap} = \frac{V_s}{1-p}, \quad L = \frac{X_L}{2\pi f}$$

Variables

Q_C	Capacitor rating at its rated voltage	var
V_C	Capacitor rated voltage	V
V_s	System voltage	V
p	Detuning factor X_L/X_C	-
f	System frequency	1/s
X_C	Capacitor reactance per phase (star)	Ω
X_L	Reactor reactance	Ω
L	Reactor inductance	H
f_r	Tuning frequency	1/s
n_r	Tuning order	-
Q_{eff}	Effective output at system voltage	var
V_{cap}	Voltage across the capacitor	V

Method and standards

Series LC relations.

Assumptions and limits

- Three-phase star equivalent.
- A capacitor voltage V_s/(1 − p) above the capacitor's rated voltage is flagged.

References

- Series LC detuning: n_r = 1/√p
- V_cap = V/(1 − p) (power factor correction practice)

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/electrical/power-quality/detuned-capacitor-reactor

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.