Single-Tuned Harmonic Filter: Design and Harmonic Current Share

Capacitor, reactor and resistor reactances of a single-tuned filter from its effective kvar, tuning order and quality factor, and the harmonic current it absorbs.

Method: Single-tuned filter design and current division

Input parameters

Unit system: SI

Parameter	Value	Unit
Bus line voltage	415.00	V
Bus short-circuit power	20.000	MVA
Filter effective kvar at fundamental	300.00	kvar
Tuning order	4.7000	
Filter quality factor	40.000	
Harmonic order of the source current	5.0000	
Harmonic current from the load	120.00	A

Calculated results

Parameter	Value	Unit
Capacitor reactance at fundamental	0.60130	Ω
Reactor reactance at fundamental	0.027221	Ω
Filter resistance	0.003198	Ω
Harmonic current into the filter	87.594	A
Harmonic current into the supply	32.880	A
Harmonic voltage at the bus	0.59086	%

Notes for this case

• X_C = (V²/Q_eff)·h_t²/(h_t² − 1), X_L = X_C/h_t², R = h_tX_L/Q_f; current divider at order h between j·hX_s and R + j(hX_L − X_C/h). Tune slightly below the target harmonic (4.7 for the 5th) so ageing capacitors and frequency drift do not push resonance onto it, and rate the capacitor for the fundamental voltage rise h_t²/(h_t² − 1) plus harmonics.

Formula and method

$$X_C = \frac{V^2}{Q_{eff}} \frac{h_t^2}{h_t^2 - 1}, \quad X_L = \frac{X_C}{h_t^2}, \quad R = \frac{h_t X_L}{Q_f}, \quad I_{f,h} = I_h \frac{Z_s(h)}{Z_s(h) + Z_f(h)}$$

Variables

V	Bus line voltage	V
S_{sc}	Bus short-circuit power	VA
Q_{eff}	Filter effective kvar at fundamental	var
h_t	Tuning order	-
Q_f	Filter quality factor	-
h	Harmonic order of the source current	-
I_h	Harmonic current from the load	A
X_C	Capacitor reactance at fundamental	Ω

X_L	Reactor reactance at fundamental	Ω
R	Filter resistance	Ω
$I_{f,h}$	Harmonic current into the filter	A
$I_{s,h}$	Harmonic current into the supply	A
V_h	Harmonic voltage at the bus	-

Method and standards

Filter design.

Assumptions and limits

- Inductive source at harmonics; one dominant harmonic.

References

Single-tuned filter design and current division

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/single-tuned-filter-harmonic-share

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.