RC Snubber Design from the Measured Ringing Frequency

Parasitic capacitance and inductance of a switching node from its ringing frequency with and without a test capacitor, and the damping RC snubber and its loss.

Method: RC snubber design from the measured ringing frequency (parasitic L and C found by adding a known capacitor)

Input parameters

Unit system: SI

Parameter	Value	Unit
Ringing frequency as measured	40.000	MHz
Test capacitor added across the switch	100.00	pF
Ringing frequency with the test capacitor	20.000	MHz
Snubber capacitor as a multiple of the parasitic capacitance	4.0000	
Voltage switched	48.000	V
Switching frequency	200.00	kHz

Calculated results

Parameter	Value	Unit
Parasitic capacitance	33.333	pF
Parasitic inductance	474.94	nH
Snubber resistance (characteristic impedance)	119.37	Ω
Snubber capacitance	133.33	pF
Power in the snubber resistor	0.061440	W

Notes for this case

• The ringing at a switching node is the parasitic inductance resonating with the parasitic capacitance. Adding a known capacitor C_t lowers the frequency from f₀ to f₁; since f ∝ 1/√C, C_p = C_t/[(f₀/f₁)² − 1] and L_p = 1/[(2πf₀)² C_p]. A resistor equal to the characteristic impedance √(L_p/C_p), in series with a capacitor several times C_p, damps the ring critically. The resistor dissipates about C_s V² f_s whatever its value: choose the smallest capacitor that damps well enough.

Formula and method

$$C_p = \frac{C_t}{(f_0/f_1)^2 - 1}, \quad L_p = \frac{1}{(2\pi f_0)^2 C_p}, \quad R = \sqrt{\frac{L_p}{C_p}}, \quad P_R = C_s V^2 f_s$$

Variables

f_0	Ringing frequency as measured	1/s
C_t	Test capacitor added across the switch	F
f_1	Ringing frequency with the test capacitor	1/s
k	Snubber capacitor as a multiple of the parasitic capacitance	-
V	Voltage switched	V
f_s	Switching frequency	1/s
C_p	Parasitic capacitance	F
L_p	Parasitic inductance	H
R	Snubber resistance (characteristic impedance)	Ω
C_s	Snubber capacitance	F

P_R	Power in the snubber resistor	W

Method and standards

RC snubber.

Assumptions and limits

- Single dominant LC resonance; linear parasitics.

References

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Report details

Report reference	FCC-RPF5-PC2C (the same inputs always give the same reference)
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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/electronics/rc-snubber-design

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Reopens the calculator with the inputs of this report.