EE-463 STATIC POWER CONVERSION-I

Snubbers and Protection Circuits

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What is a Snubber?

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- Limit voltage transients
- Limit dv/dt to protect devices and prevent accidental turn-on
- Reduction of switching losses
- Reduce EMI
- Prevent arcing in mechanical relays etc.

More info

Reasons for Transients

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Mostly due to stray/parasitic inductances

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- Device inductance
- PCB or line inductance

RC Snubber

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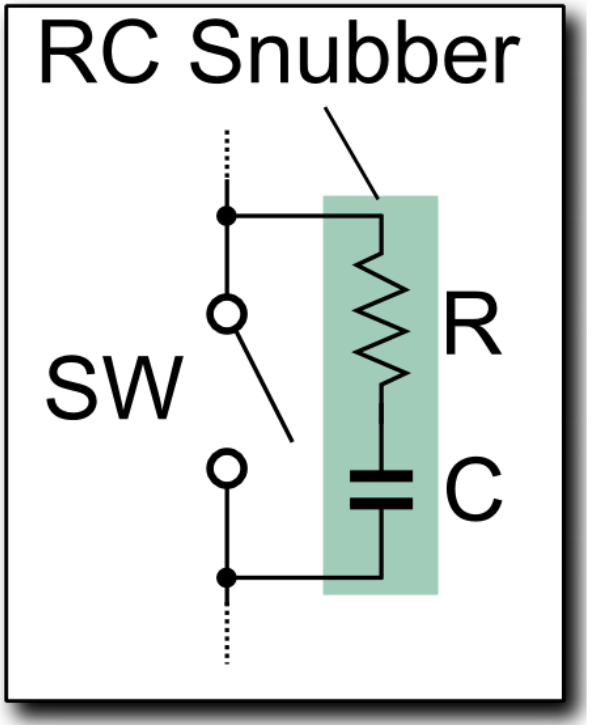

RC Snubber

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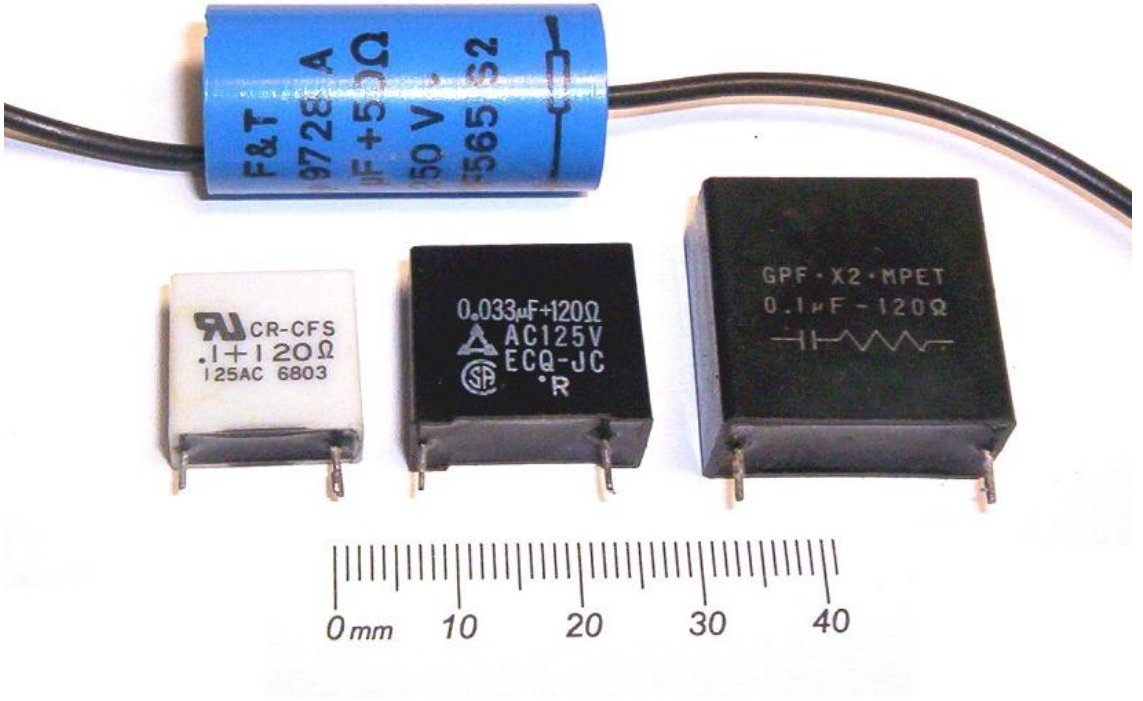
F&T
CR-CFS
.1+120Ω
125AC 6803
0.033μF+120Ω
AC125V
ECQ-JC
GPF · X2 · MPET
0.1μF - 120Ω
0 mm
10
20
30
40

Reasons to Use Snubber

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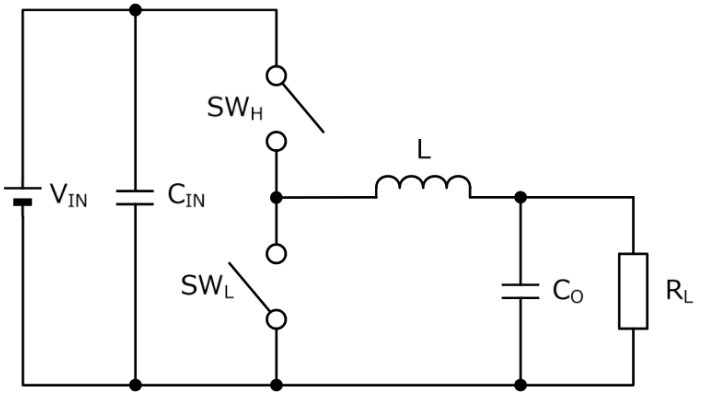
Common Parasitic Components

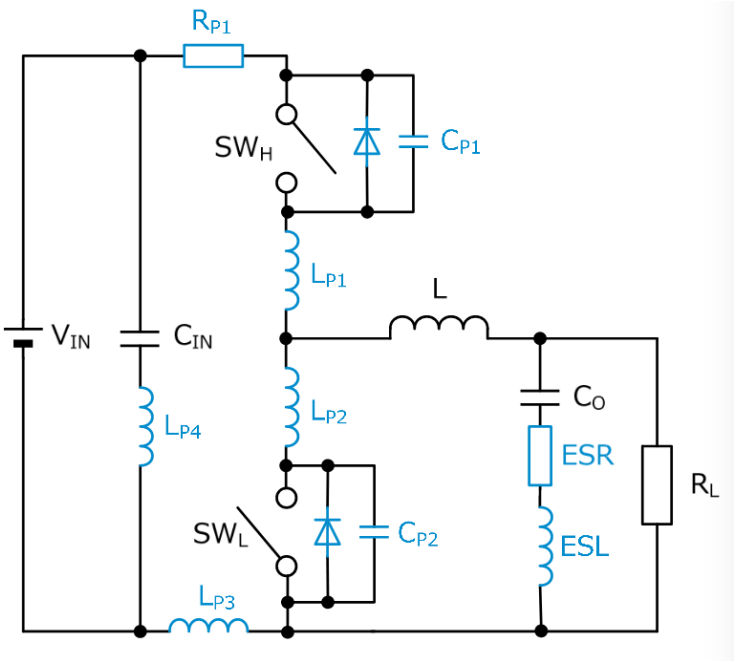
Reasons to Use Snubber

Common Parasitic Components

Example: Synchronous Buck

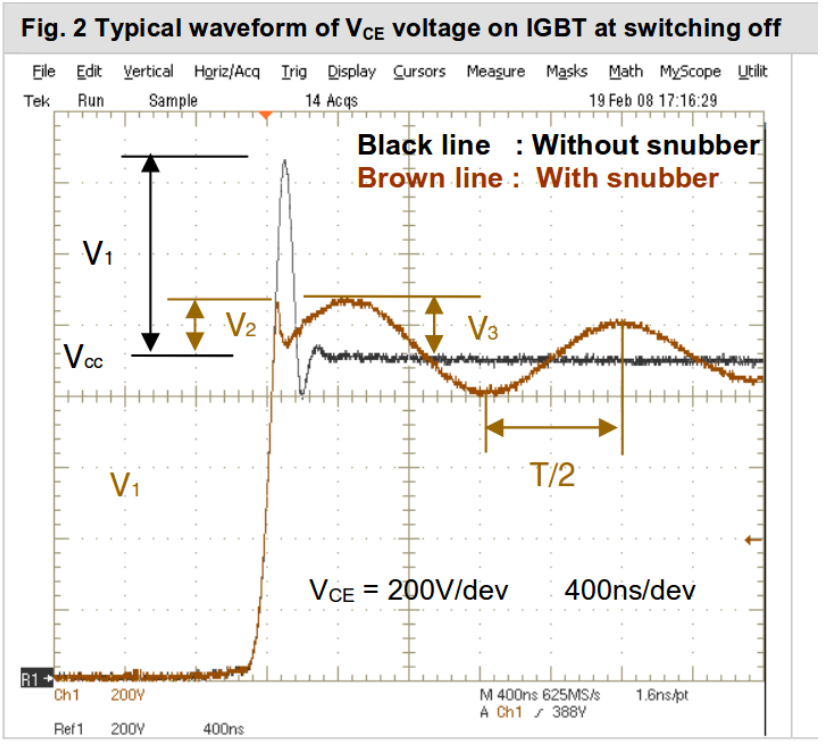


Synchronous Buck with Parasitic Components

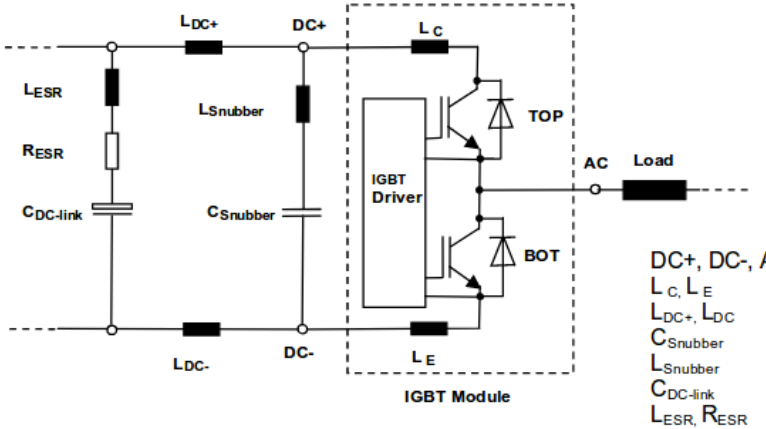


Voltage Waveforms (For IGBT)

Fig. 2 Typical waveform of V_{CE} voltage on IGBT at switching off



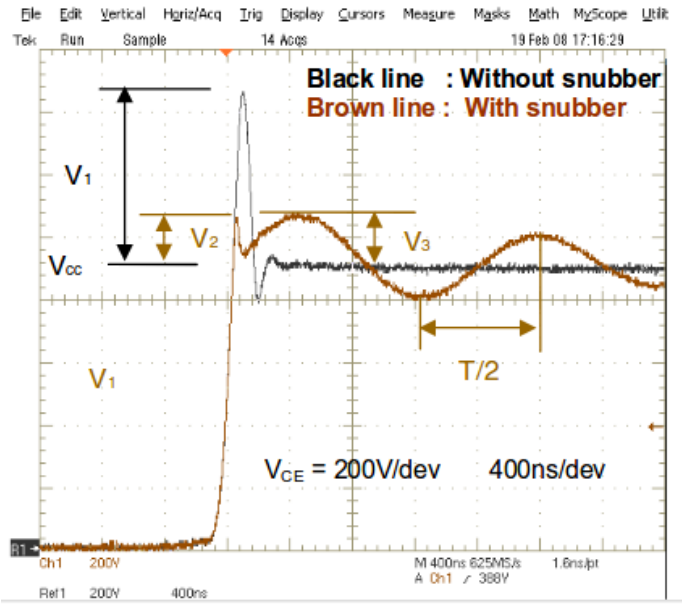
Equivalent Circuit for IGBT



DC+, DC-, AC	IGBT module terminals
L_C, L_E	IGBT module parasitic inductance
L_{DC+}, L_{DC}	Bus bar parasitic inductance
$C_{Snubber}$	Snubber capacitor capacitance
$L_{Snubber}$	Snubber capacitor series inductance
$C_{DC-link}$	DC-link capacitor capacitance
L_{ESR}, R_{ESR}	DC-link capacitor parasitics

Snubber Equations

Fig. 2 Typical waveform of V_{CE} voltage on IGBT at switching off



$$\Delta V_1 = \Sigma L \cdot di_c / dt$$

$$\Delta V_2 = (L_C + L_E + L_{Snubber}) \cdot di_c / dt$$

$$\Delta V_3 \le \sqrt{\frac{L_{DC-Link} \cdot i_c^{\,2}}{C_{Snubber}}}$$

$$f = \frac{1}{T} = \frac{1}{2 \cdot \pi \cdot \sqrt{L_{DC-Link} \cdot C_{Snubber}}}$$

$$\Sigma L = L_C + L_E + L_{DC+} + L_{DC-} + L_{ESR}$$

$$L_{DC-Link} = L_{DC+} + L_{DC-} + L_{ESR}$$

RC Snubber Applications Notes

RC Snubber Applications Notes

- Designing RC Snubber Networks
- Calculate R-C Snubber in 7 Steps
- Snubber Circuit for Buck Converter
- IGBT Snubber Capacitors

Diode Snubbers

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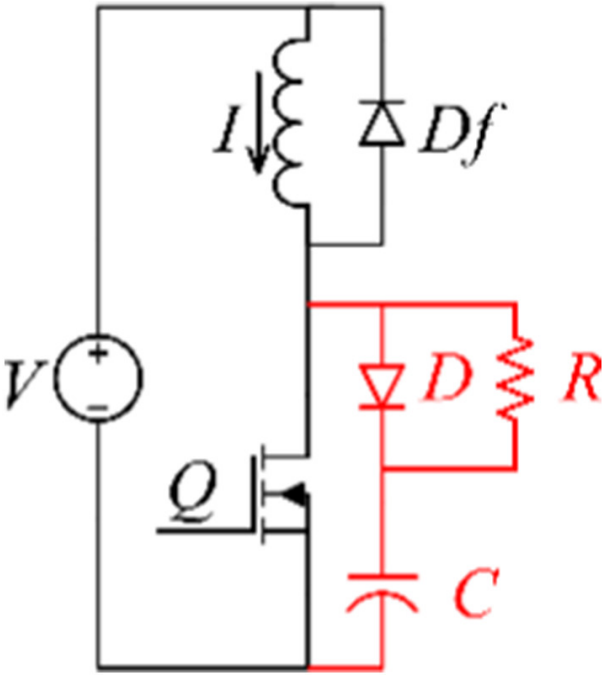
Freeewheeling diode is a very basic snubber

Diode Snubbers: RCD Snubber

Diode Snubbers: RCD Snubber



Diode Snubbers: RCD Snubber

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Flyback Converter (Wait until EE464) with RCD Snubber

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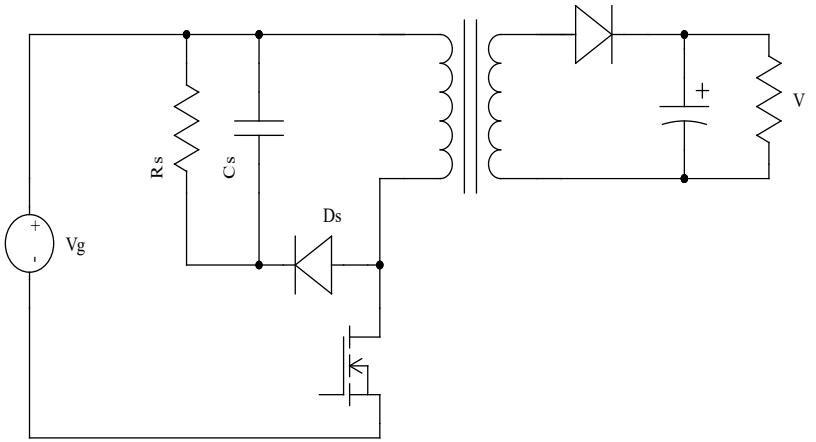
Flyback Converter (Wait until EE464) with RCD Snubber



Absorbs the current in the leakage inductor

RCD Application Note, RCD Design

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