

1 *Silicon chip snubbers for 600 V applications with a polyimide surface passivation (device area of 14.3 mm<sup>2</sup> and 6.8 mm<sup>2</sup> respectively)*

## SILICON INTEGRATED RCD-SNUBBER NETWORKS

### General description

Based on our established technology for monolithic RC-snubbers the silicon integrated RCD-snubber networks combine a deep trench MOS capacitor with a resistor which is formed by the bulk resistance of the silicon substrate. For the RCD-snubber pn-diodes are integrated into the silicon substrate. Different implementations allow for the realization of RCD-snubbers for voltage rise control and for voltage clamping.

### Features

- Available as bare die silicon chips
- Whole back side area can be soldered or sintered onto a power electronic substrate (e.g. DBC, lead frame)
- Very small temperature dependence of the capacitor (< 50 ppm/K)
- Extremely low stray inductance (< 100 pH)

### Advantages

- Compact module design (one silicon chip replaces three or more discrete passive components)
- Packaging compatible with power semiconductor devices
- Improved thermal connection to heat sink similar to power semiconductor devices
- Reduced voltage overshoots in power modules
- Improved EMC of power module or power switch

### Benefits

- Cost savings and improved reliability due to uniform packaging
- More competitive products because of technological advantages
- Increased market volume due to conformity with EMC regulations

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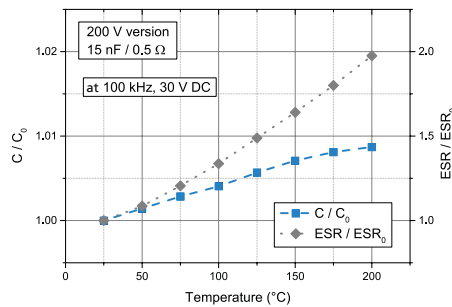
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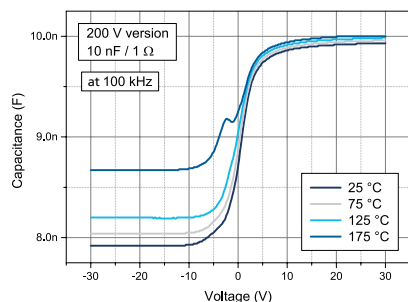
**General characteristics**

Nominal voltage	up to 600 V
Temperature range	-40 °C – 200 °C
Climatic category	40 / 200 / 56
Capacitance range	0.5 nF – 50 nF (typ.)
Temp. coefficient of the capacitance	~ 50 ppm/K
Resistance range	10 mΩ – 10 Ω (typ.)
Temp. coefficient of the resistance	~ 5000 ppm/K
Blocking voltage of the diode	> 900 V

**Temperature characteristic of the snubber's capacitor and resistor**



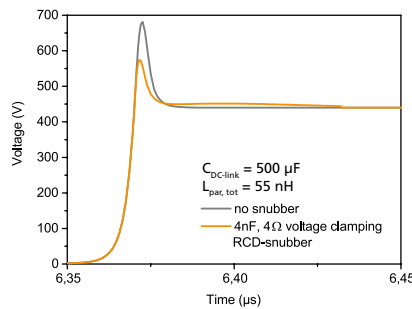
**Capacitance voltage characteristics on a lightly doped silicon substrate**



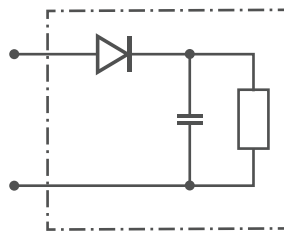
In unipolar operation the capacitance is largely independent of the voltage.

**Voltage clamping snubber**

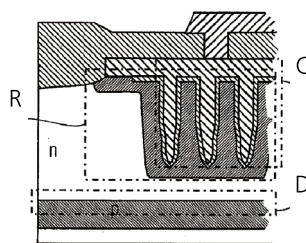
The voltage clamping RCD-snubber limits the voltage overshoot at a protected device (e.g. a MOSFET), as the following graphic illustrates with SPICE simulation results for a half-bridge power module.



The topology of a voltage clamping RCD-snubber...



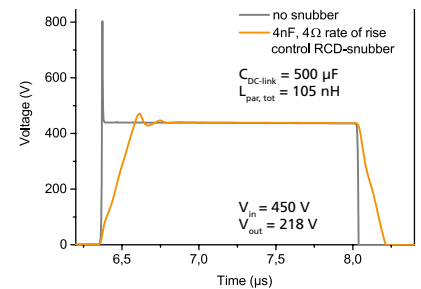
... can be integrated on a silicon chip with a technology that is patented by Fraunhofer IISB (US7738226 B2):



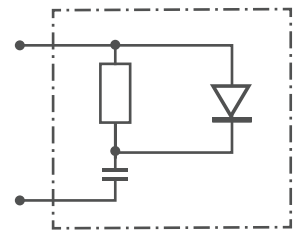
**2** Cross-section image of a monolithically integrated capacitor taken by scanning electron microscopy.

**Voltage rise control snubber**

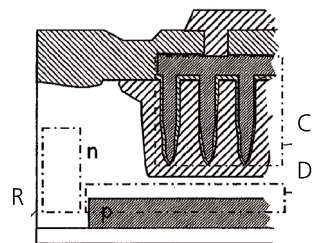
The RCD-snubber for voltage rise control limits the voltage slope during the turn-on and turn-off at a protected device. This is shown below in SPICE simulation results of a half-bridge-based DC/DC converter.



The topology of an RCD-snubber for voltage rise control...



... can also be realized on a silicon chip with a technology that is patented by Fraunhofer IISB (US7738226 B2):



**3** Silicon integrated snubber chip assembled on a DBC substrate next to active power electronic devices.

