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# **Experiments with two series-resonant isolated DC-DC converters in ISOP configuration**

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# 20 kW / 2U





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# Outline

# □ Introduction

# Design issues (10 kW SRDAB)

- magnetic components
- overall layout
- □ Experiments (SRDAB / EV system)
  - scope records
  - power losses/efficiency measurements
- □ Conclusion







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#### Introduction

#### **Expected direction of transport development**



Source: "Fast EV-Charging with CoolSiC<sup>TM</sup>," 2021, [Online].

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#### Introduction

#### **EV charger structure**



This work is a part of "Power electronic energy management system in the fastcharging energy storage processes" project co-financed by the National Center for Research and Development under the competition "Sciezka dla MAZOWSZA"



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## Introduction

#### **EV charger structure**



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#### Demonstrator

#### **DC-DC SRDAB converters**



M2



Symbol	Parameter	Value	Unit
$V_1$ or $V_2$	Input voltage	400	V
V <sub>BAT</sub>	Output voltage	800	V
P <sub>n</sub>	Rated power	10	kW
$f_{\rm s}$	Switching frequency	100	kHz
$T_1 \div T_4$	SiC MOSFETs	MSC035SMA070B4	-
$T_{1S} \div T_{4S}$	SiC MOSFETs	NVH4L040N120SC1	-
$n = n_1 / n_2$	Transformer ratio	1/2	-
$L_{\rm r}$	Resonant inductor	8	μΗ
C <sub>r</sub>	Resonant capacitor	1.188	μF
С	DC-link capacitors	180	μF
$L_{\rm F}$	Output filter inductor	33	μΗ
C <sub>F</sub>	Output filter capacitor	1.2	μF





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#### Demonstrator

#### DC-DC SRDAB converters (details)

**Magnetic components design** – two approaches:

- Transformer with regulated leakage inductance
- Low leakage inductance transformer and additional resonant inductor



- numbers of primary and secondary turns;
- the core geometry;
- the geometry of windings;
- practical realization.









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#### Demonstrator

#### DC-DC SRDAB converters (details)





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#### Demonstrator

#### **DC-DC SRDAB converters (details)**

**Approach 1:** Transformer with regulated leakage inductance











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#### **Demonstrator**

#### **DC-DC SRDAB converters (details)**

Approach 2: Low leakage inductance transformer and additional resonant inductor









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#### Demonstrator

#### **DC-DC SRDAB converters – experiments**

#### Laboratory tests of SRDAB



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#### **DC-DC SRDAB converters – experiments**







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#### Demonstrator

#### **DC-DC SRDAB converters – experiments**



1st Workshop on Advanced Charging Systems WACS 2022 – September 28, 2022

#### Power losses measurement



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#### Demonstrator

#### **Complete system**

#### 20 kVA Vienna rectifier

#### $2 \ge 10 \text{ kW DC-DC SRDABs}$



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#### Experiments







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## Conclusion

- experimental validation of a 2x10 kW rated SiC-based two seriesresonant isolated DC-DC converters in ISOP configuration has been shown
- complete (with VR) demonstrator of EV charger has been built in 4U rack system
- at the nominal power overall efficiency of the charger was measured at nearly 96% level and 97% at the half of nominal power

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# ... Thank you for your attention.

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