



MARKEL Sp. z o.o, Piaseczno, Poland

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

Mariusz ZDANOWSKI

Grzegorz WRONA

Przemysław TROCHIMIUK

Jacek RĄBKOWSKI

Radosław SOBIESKI

20 kW / 2U





P IS EP

MARKEL Sp. z o.o, Piaseczno, Poland

Outline

□ Introduction

Design issues (10 kW SRDAB)

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







MARKEL Sp. z o.o, Piaseczno, Poland

Introduction

Expected direction of transport development



Source: "Fast EV-Charging with CoolSiCTM," 2021, [Online].

WARSAW UNIVERSITY OF TECHNOLOGY INSTITUTE OF CONTROL AND INDUSTRIAL ELECTRONICS



MARKEL Sp. z o.o, Piaseczno, Poland

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"



4

WARSAW UNIVERSITY OF TECHNOLOGY INSTITUTE OF CONTROL AND INDUSTRIAL ELECTRONICS



MARKEL Sp. z o.o, Piaseczno, Poland

Introduction

EV charger structure



Varsaw University of Technology

WARSAW UNIVERSITY OF TECHNOLOGY INSTITUTE OF CONTROL AND INDUSTRIAL ELECTRONICS

MARKEL Sp. z o.o, Piaseczno, Poland



Demonstrator

DC-DC SRDAB converters



M2



Symbol	Parameter	Value	Unit
V_1 or V_2	Input voltage	400	V
V _{BAT}	Output voltage	800	V
P _n	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	μH
C _r	Resonant capacitor	1.188	μF
С	DC-link capacitors	180	μF
$L_{\rm F}$	Output filter inductor	33	μΗ
C _F	Output filter capacitor	1.2	μF





MARKEL Sp. z o.o, Piaseczno, Poland

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.









MARKEL Sp. z o.o, Piaseczno, Poland

Demonstrator

DC-DC SRDAB converters (details)





MARKEL Sp. z o.o, Piaseczno, Poland



Demonstrator

DC-DC SRDAB converters (details)

Approach 1: Transformer with regulated leakage inductance











MARKEL Sp. z o.o, Piaseczno, Poland

Demonstrator

DC-DC SRDAB converters (details)

Approach 2: Low leakage inductance transformer and additional resonant inductor









MARKEL Sp. z o.o, Piaseczno, Poland

Demonstrator

DC-DC SRDAB converters – experiments

Laboratory tests of SRDAB



11





MARKEL Sp. z o.o, Piaseczno, Poland

Demonstrator

DC-DC SRDAB converters – experiments







MARKEL Sp. z o.o, Piaseczno, Poland

Demonstrator

DC-DC SRDAB converters – experiments



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

Power losses measurement



P W IS EP

MARKEL Sp. z o.o, Piaseczno, Poland

Demonstrator

Complete system

20 kVA Vienna rectifier

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



WARSAW UNIVERSITY OF TECHNOLOGY INSTITUTE OF CONTROL AND INDUSTRIAL ELECTRONICS



MARKEL Sp. z o.o, Piaseczno, Poland

Experiments







MARKEL Sp. z o.o, Piaseczno, Poland

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

WARSAW UNIVERSITY OF TECHNOLOGY INSTITUTE OF CONTROL AND INDUSTRIAL ELECTRONICS



17

MARKEL Sp. z o.o, Piaseczno, Poland

... Thank you for your attention.

Progress in Applied Electrical Engineering PAEE 2022 - June 28, 2022