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# Experimental Verification of Novel Bi-Directional qZSI Based DC/DC Converter for Short Term Energy Storage Systems

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**Abstract.** This paper presents a new bi-directional isolated DC/DC converter for supercapacitor (SC) interfacing. During the SC charging mode, the converter operates as a VSI-based step-down DC/DC converter and during the energy recovery mode, as a qZSI-based step-up DC/DC converter. For galvanic isolation and voltage matching a medium frequency transformer was implemented. To achieve higher SC voltage boost the qZSI with the two-stage quasi-Z-source (qZS) network was introduced. The paper discusses the PSIM simulation and experimental results of proposed converter operating with a 14.4 V 142 F supercapacitor.

## Key words

DC/DC converter, quasi-Z-source inverter (qZSI) supercapcitor, energy storage.

## 1. Introduction

Today's supercapacitors (SC) represent an innovative solution for energy storage applications. One of the most challenging applications of a SC is the energy buffering in distributed power generation systems with fuel cells (FC) and/or photovoltaic (PV) cells. Since FC and/or PV powered residential power supply systems cannot respond fast on short, high power demand spikes, a short-term controllable energy storage buffer (supporting system) should be introduced at the main system (supported system) DC bus. The supported system (SS) side DC bus voltage ($U_{SS}$) should be 600 V for residential applications with 1-phase (230 VAC) or for 3-phase (400 VAC) loads.

In high-power applications with a SC, it necessary to elaborate suitable power electronic interfaces, which enable an efficient and reliable transfer of energy between SC storage and a supported energy system [1]. To control both the charging and discharging processes of the SC, the interface converter should be two-quadrant (bi-directional).

This paper reports the results of work continued by the power electronic group of Tallinn University of Technology in 2009 [2]. A brand new interface converter for SC interfacing was developed and experimentally tested. The topology presented (Fig. 1) consists of a voltage-source half-bridge inverter (VSI) on the supported energy system side, a medium frequency voltage matching transformer and a voltage-fed quasi-Z-source inverter (qZSI) on the SC side. In this study, the half-bridge VSI on the SS side is proposed in order to decrease the transformer's turns ratio.

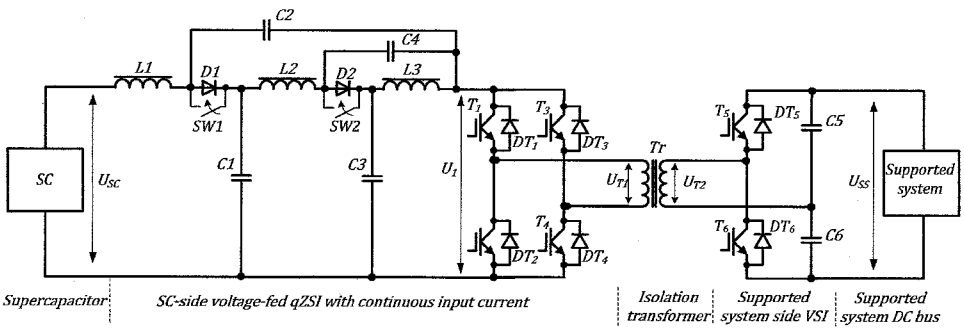


Fig. 1. Simplified power circuit diagram of the proposed converter.