**Piotr PATYK, Michał BONISŁAWSKI, Marcin HOŁUB**

West Pomeranian University of Technology, Szczecin,
Department of Power Systems and Electrical Drives

# Power electronic converter for small power hydrogenerators

***Abstract***. *Proposed paper gives an overview of the design and performance of a power electronic converter designed to efficiently rectify the alternating voltage of the permanent magnet AC generator to direct current, that may be used to charge batteries and/or power devices from a small hydrogenerator. The generator design is also briefly discussed aimed for electricity generation by the motion of an undersail boat. Simulation results and test – stand results are presented.*

**Keywords:** Power converter, hydrogenerator, switched mode converter, converter topology.

## Introduction

The yachting market of today offers a range of distributed energy generation solutions based on photovoltaics, small power wind energy generators or internal combustion engine based generators [1]. An article from “Yachting World” [2] mentions a first use of a small power hydrogenerator used during the world race Venée Globe in 2008. Beginning in 2017 small power hydrogenerators are to be a main energy source during the Volvo Ocean Race [3]. A limited number of providers offers small power hydrogenerators for yachting including Watt&Sea Cruising Hydrogenerator (300W, 40V, nom. speed 5 knots), Save Marine generators (max. 500W), Seamap (100W, max. 5 knots), Electric Energy Limited solution (350W). A preliminary design of a small power (150 W, 5 knots) hydrogenerator was also performed in the laboratories of West Pomeranian University of Technology, Szczecin. The prototype constructed is depicted in Fig. 1.

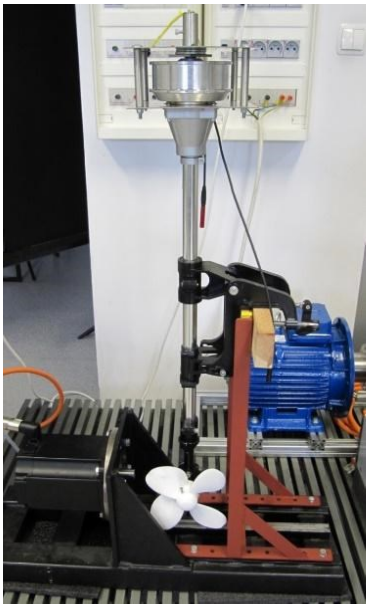

Fig.1. Prototype construction of a small power hydrogenerator with a BLDC generator.

## Power electronic converter topology

Converter design was aiming at simplicity and limited costs. Different input rectifier constructions were considered [4]. A centralized passive diode bridge – single switch boost converter topology was proposed for input current control purposes. To adjust the output voltage level to battery system arrangement a push – pull converter is proposed. The overall converter construction is depicted in Fig. 2.

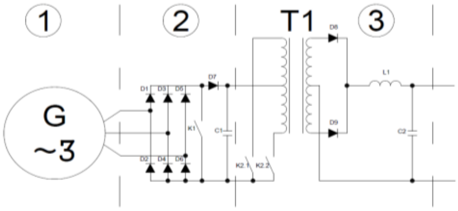


Fig.2. Proposed power electronic converter topology: 1 – AC, permanent magnet excited generator, 2 – rectifier with a boost converter, 3 – a push – pull output voltage controller.

In order to verify properties of proposed power electronic load systems simulation models were constructed using the PLECS environments.

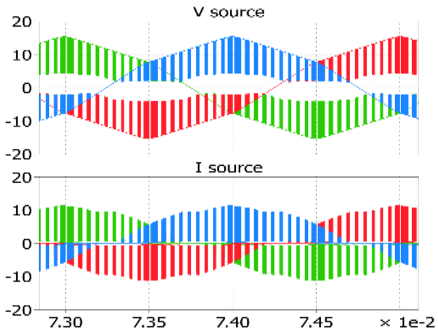


Fig.3. Generator - rectifier operation, above: generator voltage, below: generator currents.

## Summary and conclusions

Full version will include detailed description of the simulation results, comparison to results obtained in simulated and real conditions of generator operation. Efficiency map will be provided with efficiency improvement methods.

## References


1. A. Accetta and M. Pucci, "A first approach for the energy management system in DC micro-grids with integrated RES of smart ships," 2017 IEEE Energy Conversion Congress and Exposition (ECCE), Cincinnati, OH, 2017, pp. 550-557, doi: 10.1109/ECCE.2017.8095831.
2. “Wind, water and solar power: how alternative energy has been transformed” ,Yachting World, URL:http://www.yachtingworld.com/gear-reviews/wind-water-and-solar-power-65797, [access 17.06.2017].
3. Duncan K.: Hydrogenerators – tested, Sailing Today, URL: http://www.sailingtoday.co.uk/gear/gear-on-test/hydrogenerators/, [accessed 17.06.2017 ].
4. Vilathgamuwa, Mahinda D.,Jayasinghe S. D. G.: Rectifier systems for variable speed wind generation-a review, Industrial Electronics (ISIE), 2012 IEEE International Symposium on. IEEE, 2012.



***Authors**: mgr inż Piotr Partyk, dr hab. inż. Marcin Hołub and dr inż Michał Bonisławski are with the West Pomeranian University of Technology, Szczecin, Sikorskiego 37, 70-313 Szczecin, e-mail: mholub@zut.edu.pl;*