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Development of a Low Speed Linear Generator for use in a Wave Energy Converter

J. Ribeiro[1] and I. Martins[1]

[1] Department of Electrical and Electronics Engineering
I.S.E., University of Algarve
Campus of Penha – Faro, 8000 Faro (Portugal)
Phone/Fax number: +351 289 800165, e-mail: **joseribeiro.eee@gmail.com**, **imartins@ualg.pt**

Extended Abstract. One of the main advantages of ocean waves as resource for electrical energy production is its high energy density. Several methods have been proposed for the conversion of ocean wave energy into electrical energy. One such method consists in the use of a direct drive linear generator enclosed inside a floating element. The generator is driven by a mass-spring system, which oscillates due to the ocean wave's movement.

In this paper are presented the study, development, and dynamic simulation of a linear tubular synchronous low speed permanent magnet generator, for use in a wave energy conversion system. The electrical machine's topology, which is also slotless, has as advantage a higher force density when compared to a flat linear machine. It also offers a robust mechanical assembly. However, being slotless, only high magnetic energy density permanent magnets can be used. The generator was dimensioned using a finite element analysis tool, in order to obtain more accurate results.

The wave energy converter dynamic model, mechanical and electrical, was developed to evaluate its response. The buoy's dynamic model is a simplified model (2DOF), designed to allow the simulation of the generator integrated in a floating element. For the electrical machine two distinct models were developed for comparison. The first models the generator as seen from the DC rectifier's output: a DC generator. The second models the machine as a multiphase PM synchronous generator. Both models present advantages and disadvantages. The second model was used to analyze the system's dynamic response due to its high range and quantity of supplied data. Both models use finite element analysis to 'map' the generator.

To validate the generator's dimensioning and dynamic model, its prototype was built. The dynamic model simulation results and the prototype's experimental results are presented.