Direct Drive Wave Energy Converter Control in Irregular Waves

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Work stream 5:Power take-off and conditioning

Introduction

Previous work on direct-drive wave energy converters has concentrated on regular (single frequency) waves [1]. This poster describes how the power converter currents can be controlled in real conditions of highly irregular waves to provide appropriate generator reaction force such that mechanical resonance and, hence maximum power take-off, is achieved.

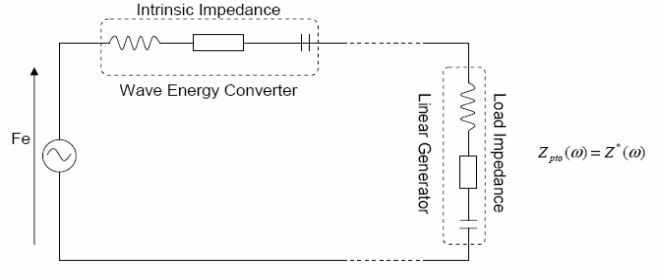

Fig.2: Electrical description for calculating power take-off force

System Description

• This poster assumes that the waveshape of the incoming (irregular) waves with variable frequencies and amplitudes is known.

• Output currents have variable frequencies and amplitudes need to be controlled to achieve mechanical resonance.

• A back-to-back power converter is applied. Rectifier is used to control currents and inverter is used to control DC link voltage.

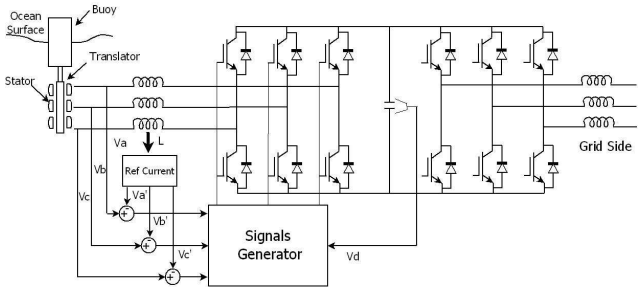

Fig.1: Whole system of direct drive linear generator control

Control Method

The Mechanical system can be described using an electrical system. Based on the maximum power transfer theorem, load impedance should match the intrinsic impedance. The wave energy converter can be considered as a simple mass-spring-damper which can be represented by an RLC circuit. Therefore, the load is also considered as an RLC circuit.

$$F_{pto} = -[m + M_s]a(t) + B_s u(t) - cx(t)$$

PWM Generation

Because of irregular waves are considered in this poster, traditional carrier based idea is not working here. After defining the switching cycle, the short-term average voltage is calculated by giving duty ratio.

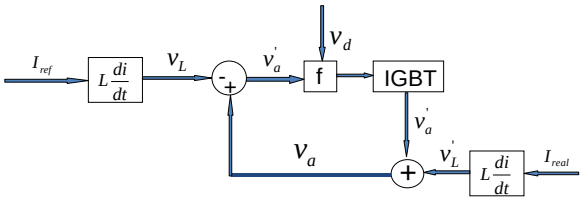

Fig.3: Feedback control method by defining duty ratio

Simulation Results

Currents from linear generator can be controlled by making the instantaneous average voltage follow the reference voltage. Switching frequency is defined as 1KHz.

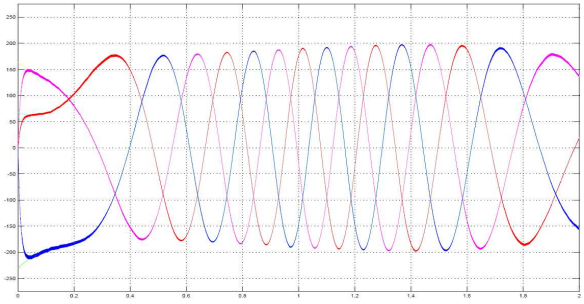

Fig.4: Controlled currents and ideal currents

References

1 J.K.H.Shek, D.E.Macpherson, M.A.Mueller, and J.Xiang, "Reaction force control of a linear electrical generator for direct drive wave energy conversion," *IET renewable power generation*, 2007, pp.17-24.

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