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State-Space Model Representation to Characterize an Energy Harvesting Circuit

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Extended Abstract

For several years now, research has been undertaken to improve the DC harvested power of energy harvesting circuits and the use of multi-tone signals has shown increased performance. In the case of power transfer, [1] has thus shown that the use of power-optimized waveform (POW) considerably affects the efficiency of the rectifier. With an optimal range of the sub-carrier spacing, the voltage ripple and the total number of sub-carriers, a relationship has been established in order to maximize the efficiency of a single-shunt rectenna.

The current trend is now to take into account the transmission channel. The radio-frequency source (multi-sine), the canal and the rectenna are considered as a global wireless power transfer (WPT) system. [2] described the influence of a realistic channel on the overall efficiency. For a static multi-path channel, the efficiency can quickly decrease in the case of an important frequency-selective channel with large signal bandwidth. Waveform adaptation algorithms according to the characteristics of the channel have thus been developed [3] and verified experimentally [4].

This extended abstract describes an original solution to maximize the DC power harvested in a WPT scenario. Figure 1 shows the principle which is in the use of state-space models to represent the elements of the global WPT system. Three main aspects of a WPT system are taken into account: the RF multi-sine source, the propagation channel and the rectifier. Each of its elements find their representation by a state-space model matrix and the algorithm optimization will become a convex optimization resolution. Different works have been already realized in the use of vector-fitting to model the linear parts of the rectifier [5]. These results are the first step of the state-space model of a global WPT system. The future works target the state-space model of the multi-path propagation channel (MOESP method) and the state-space model of the non-linear part of the rectifier (Nodal DK method). Thus a validation could be carried out in order to verify that a rectifier modeled in the form of a state-space matrix gives the same results as this same rectifier simulated using a circuit-system tool (ADS).

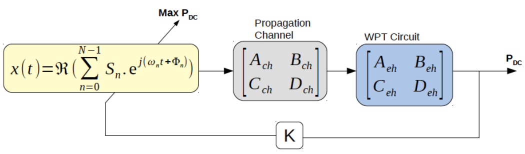

Figure 1. A WPT system model. The propagation channel and the rectifying circuit are modeled by their respective state-space models.

References

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