An efficient way of simultaneous wireless information and power transfer using hybrid rectifier-receiver

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Abstract: Simultaneous Wireless Information and Power Transfer (SWIPT) is considered an important enabler for the Internet of Things. Frequent replacement of batteries is costly in a dense wireless network, therefore harvesting ambient energy from modulated signals, such as energy harvesting from a television broadcast transmitter, has been studied [1]. In addition to ambient energy harvesting, modulated signals can be transmitted to transfer both information and data to wireless battery-limited device. To enable energy harvesting, the node consists of a rectifier, which is a device that allows RF signal to DC power conversion. Besides passive circuits, this device consists of a nonlinear component that creates new frequencies, e.g., DC, and baseband (BB) from the input signals. The circuit block diagram is shown in Fig. 1. One way to increase the RF to DC conversion is to optimize the circuit's architecture, e.g., providing a proper R, C, and harmonic terminations [2].

Relying on harvesting ambient energy is not always possible, because the availability of the ambient energy is not sufficient everywhere. Therefore, having a dedicated station to provide signal is desired. This gives a degree of freedom to utilize modulated signals that are optimal for data or information transfer.

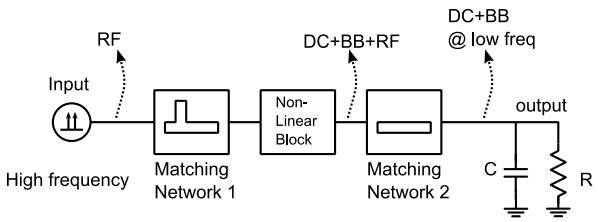

Figure 1 The system in block diagram

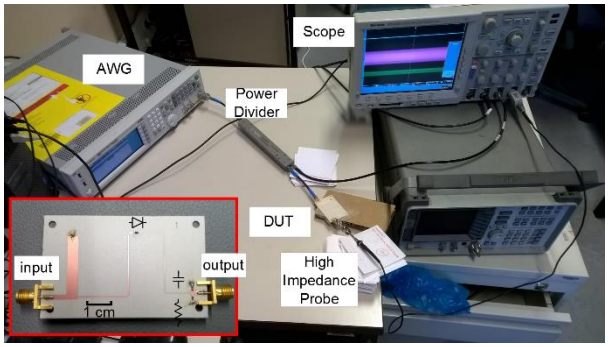

Figure 2 The realized HRR node, and the measurement setup

In a SWIPT system, also wireless information transfer has to be considered. Therefore, a receiver should be included in the node's schematic. One solution to having receiver and rectifier in the node is to use a power splitter after the antenna to have different paths for receiver and rectifier, respectively [3]. However, such a receiver requires additional power consumption in the down-converter stage (i.e., DC supply to mixer and local oscillator).

Therefore, the second option, namely passing the received signal through the nonlinear block, is investigated in this work. The data receiver then demodulates the data in the signal after conversion by the non-linear block and the RC filter after this block. By properly designing the RC filter [4], a trade-off between data rate and harvested DC power can be realized. As the signal is distorted by the nonlinear block, it renders demodulation more challenging. In this work we show that the symbols can be recovered by proper signal excitation design, given the receiver linearity and RC filter.

In this paper, we utilize a special class of modulated signals that consist of two tones, and study the trade-off for simultaneous power and information reception in a Hybrid Rectifier-Receiver (HRR) node while the data is a ratio between the two tones. The requirements of this type of signal are explained, and recovery of the received message is proved possible by measurement (Fig. 2) and analysis. Also, the corresponding node's RF to DC conversion is characterized.

References:

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