This paper presents the design of an RF energy-harvesting circuit when excited by signals with a time-varying envelope such as multi-tone signals or digitally modulated signals with random modulation. The input matching network and the output load of a rectifier circuit are simultaneously optimized using harmonic balance in order to maximize its RF-dc conversion efficiency. This paper focuses on identifying the optimum load value, which corresponds to maximum efficiency for different types of input signals. The efficiency curves versus the load value show a single optimum efficiency point, which is a different for signals with a time-varying envelope and continuous wave (CW) signals. Specifically, for the series diode rectifier that was considered, the optimal load shifts to larger values as the signal peak-to-average-power-ratio (PAPR) increases compared to a CW signal with the same average power. As a result, for certain load values a signal with a time-varying envelope can result in a larger efficiency value than a CW signal. The peak efficiency value does not necessarily improve by using a signal with a time-varying envelope. A UHF rectifier prototype is built and its performance is evaluated experimentally showing good agreement with simulation.