Jan MUĆKO

UTP University of Science and Technology, Bydgoszcz, Poland
Faculty of Telecommunications, Computer Science and Electrical Engineering

The Cockcroft-Walton voltage multiplier fed from an inverter in which the series resonant phenomena were used

Abstract. *The article describes the phenomena occurring in the Half-Wave Cockcroft-Walton voltage multiplier when it is supplied through a transformer from an inverter with a rectangular output voltage. The frequency of the inverter output voltage was selected so that a series resonant phenomena occur in the system. They are caused by the presence of voltage multiplier capacitors and transformer leakage inductances. In the article the characteristics and waveforms of voltages and currents obtained by simulation are presented. The results of simulation were used to build two prototypes with maximum powers of about 60W and 160W and a 40kV output voltage.*

Keywords: *Cockcroft-Walton* voltage multiplier, voltage multiplier, series resonant inverter, resonant load, high voltage DC generator.

Introduction

High DC voltage is typically generated by voltage multipliers. The Half-Wave Cockcroft-Walton voltage multiplier is probably the most common multiplier [1]. The operation of multiplier fed from a source of sinusoidal voltage is generally known [2]. However, in the case when the multiplier is supplied from the inverter with rectangular output voltage and frequency from several to several dozen of kHz, through the transformer, there are other electromagnetic processes, in particular are resonant phenomena. These resonant phenomena in voltage multiplier have so far been relatively little described in the literature. These are usually systems with additional resonant circuits [3 - 5]. The use of transformer leakage inductances and the capacitors of the voltage multiplier [6 - 8] (without additional resonant circuits) is the subject of this article.

Voltage and current waveforms in a voltage multipliers by supply from different sources

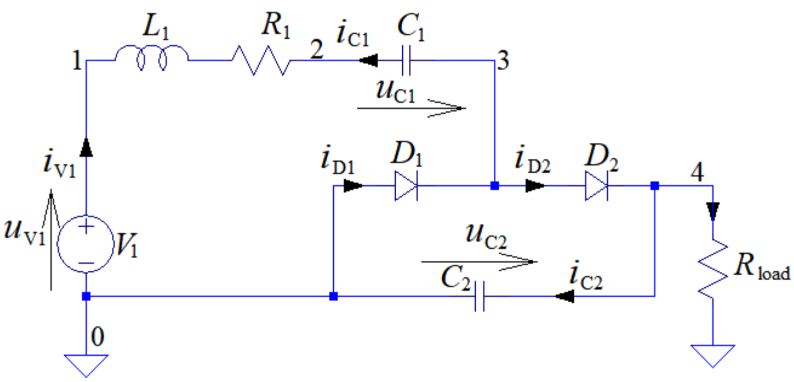

Fig.1. The diagram of the simplest voltage doubler.

Figure 1 shows the diagram of the simplest voltage doubler. Fig. 2a shows current and voltage waveforms, assuming a sinusoidal voltage at the doubler input for omitting L_1 from Fig.1. Such assumptions are very often made during the analysis of voltage multipliers and are very often wrong. If you take into account the rectangular shape of the supply voltage (inverter) and transformer leakage inductances, you get the waveforms shown in Figure 2b.

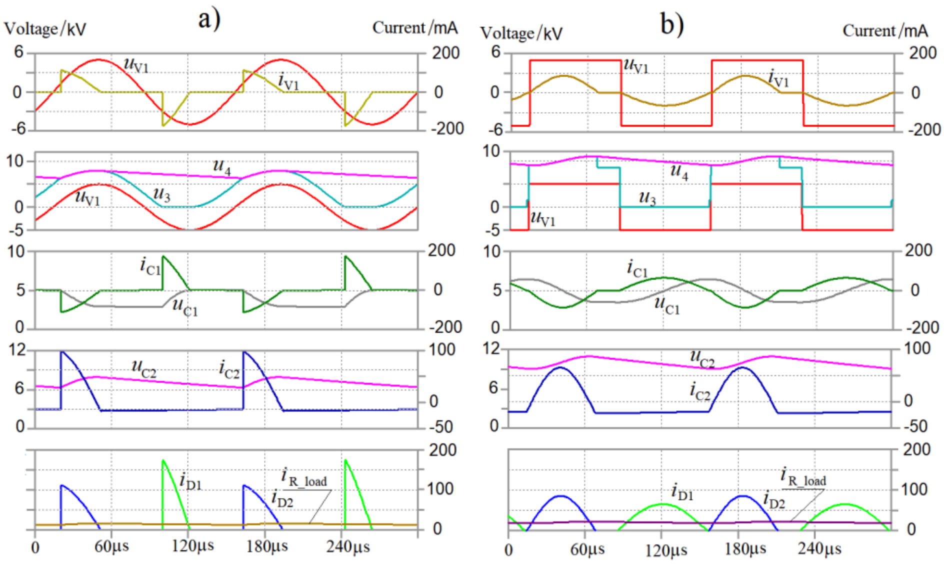

Fig.2. Current and voltage waveforms at a voltage doubler: a) by assuming a sinusoidal input voltage and omitting the L_1 from Fig.1, b) by taking into account the rectangular shape of the supply voltage and transformer leakage inductances.

Figure 3 presents a simplified scheme of voltage multiplier built from 8 diodes and 8 capacitors supplied from the inverter through a transformer. L_1 represents leakage inductances of the transformer. Figure 4 shows the voltage and current waveforms of the inverter (from Fig. 3) for different frequencies and different loads. Figures 2b and 4 clearly show the resonant phenomena which are the subject of the article.

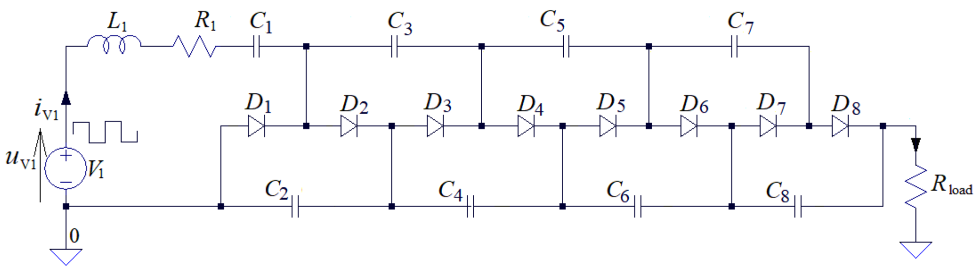

Fig.3. A simplified scheme of voltage multiplier built from 8 diodes and 8 capacitors supplied from the inverter through a transformer.

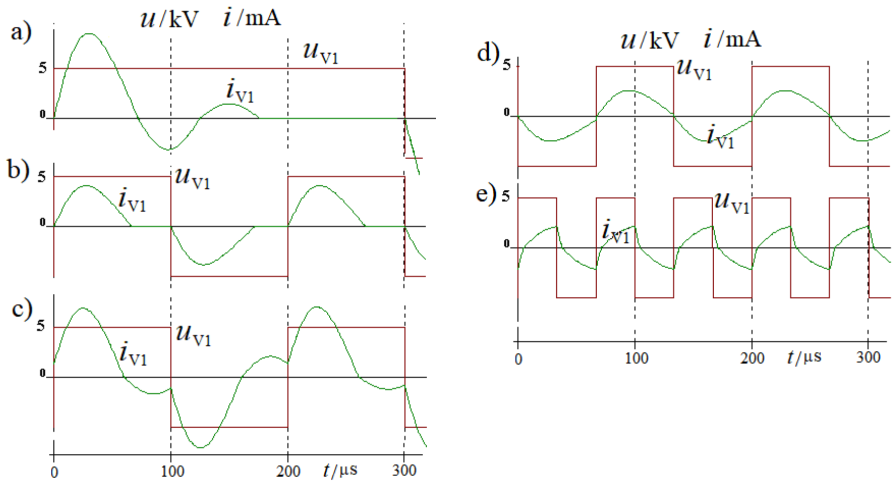

Fig.4. The voltage and current waveforms of the inverter output (from Fig. 3) for different frequencies and different loads.

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Author: *dr hab. inż. Jan Mućko, prof. at UTP; UTP University of Science and Technology in Bydgoszcz, Prof. S. Kaliskiego 7, 85-796 Bydgoszcz, Poland, e-mail:* mucko@utp.edu.pl.