Study on Split-Capacitors Applied in Positive Output Super-Lift Luo-Converters

Fang Lin Luo, Senior Member IEEE
Nanyang Technological University, Singapore
eflluo@ntu.edu.sg

Abstract — **Voltage Lift Technique has been successfully employed in design of DC/DC converters, e.g. three series Luo-Converters. However, the output voltage increases in arithmetic progression. Super Lift Technique is the most significant contribution in Power Electronics, e.g. four series Super-Lift Converters. Their output voltage increases in geometric progression. This paper introduces a novel approach – Super Lift Technique Armed by Split-Capacitors that implements the output voltage increasing in higher geometric progression. It effectively enhances the voltage transfer gain in power series as well.**

Index Terms — *Voltage Lift Technique, Super-Lift Technique, Arithmetic/Geometric Progression, Super Lift Technique Armed by Split-Capacitors, Power Series, Voltage Transfer Gain.*

I. INTRODUCTION

Voltage Lift (VL) Technique is a popular method widely used in electronic circuit design. It has been successfully employed in DC/DC converter applications in recent decades, and opened a way to design high voltage gain converters. Three series Luo-Converters [1–3] are the examples of VL technique implementations. However, the output voltage increases in stage by stage just along the arithmetic progression [4]. Super Lift (SL) Technique is the most significant contribution in Power Electronics, e.g. four series Super-Lift Converters [4, 5]. Their output voltage increases in geometric progression. This paper introduces a novel approach – Super Lift Technique Armed by Split-Capacitors that implements the output voltage increasing in stage by stage along higher geometric progression. It effectively enhances the voltage transfer gain in power series as well [6 - 8].

In order to sort these converters different from existing VL converters, we entitle these converters "Positive Output Super-lift Luo-Converters armed by Split-Capacitors". There are few sub-series, we only introduce two subseries: ***main series*** and ***additional series*** in detail in this paper, and summarize other series. Each circuit of the main series and additional series has one switch S, n inductors (where n is the stage number), other capacitors and diodes. The conduction duty ratio is k, switching frequency is f, switching period is T = 1/f, the load is resistive load R. The input voltage and current are V_{in} and I_{in}, out voltage and current are V_O and I_O. Assume no power losses during the conversion process, $V_{in} \times I_{in} = V_O \times I_O$. The voltage transfer gain is G: $G = \frac{V_O}{V_{in}}$

II. SPLIT-CAPACITORS

A capacitor C_1 as shown in Figure 1 (a) can be split into two parts: two capacitors C_1 and C_2 as shown in Figure 1 (b); and three parts: three capacitors C_1 , C_2 and C_3 as shown in Figure 1 (c). Furthermore, it can be split into α parts that are shown in Figure 1 (d).

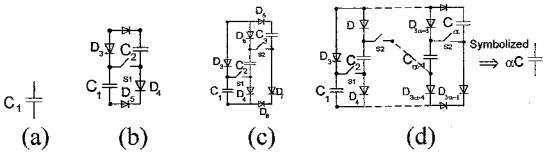

Figure 1. The single capacitor, and α split capacitors: (a) One capacitor, (b) Two Split capacitors, (c) Three Split capacitors (d) α Split capacitors.

The split stage can be defined α-times. Now, we define the single capacitor to be in α = 1 split stage as shown in Figure 1 (a); We define the two split capacitors to be in α = 2 split stage as shown in Figure 1 (b), the slave switch S1 is exclusively switched with the Main switch S; We define the three split capacitors to be in α = 3 split stage as shown in Figure 1 (c), the slave switches S1 and S2 are exclusively switched with the Main switch S. We define the α split capacitors to be symbolized by **αC**. These capacitors can be charged by a DC voltage V_{in}. In the steady-state, each capacitor is assumed to be charged to the source voltage V_{in}. All split capacitors are charged by source voltage V_{in} in parallel. When the capacitors are discharged, all split capacitors are discharged by an external voltage in series.

III. SPLIT CAPACITORS APPLIED IN THE ELEMENTARY POSITIVE OUTPUT SUPER-LIFT LUO-CONVERTER

Elementary positive output (P/O) super-lift Luo-converter is shown in Figure 2. Its circuit diagram in Figure 2 (a), and its equivalent circuits in switch-on and switch-off are shown in Figure 2 (b) and (c) respectively.