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Differential Marx Generators

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Abstract

This paper discusses the design of differential Marx generators. These are appropriate for driving differential loads such as certain antennas. This also allows higher voltages (differential) than in the single-ended case..

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1. Introduction

Marx generators are a commonly used type of high-power pulse source [4, 7]. They come in various forms (triggered or untriggered gaps). They can have fast-rising outputs through the use of peaking or transfer capacitors. Their usual configuration is, however, single ended, i.e., producing a voltage (positive or negative) with respect to some local "ground".

Some loads of interest are differential in form. In particular some antennas, such as loops [2, 6], take this form. Even reflector antennas can use a differential feed [1, 3]. Thus one needs differential sources to drive such loads. Here we suggest the possibility of differential Marx generators.

2. Differential Marx Generator

As indicated schematically in Fig. 2.1, one can have a differential Marx generator by simply taking two such generators, one operating plus and the other minus. As indicated in the figure one can have a symmetry plane between the two "halves". The electromagnetic fields then take the antisymmetric form [8]. If the generators produce $\pm V$, then the voltage delivered to the load (differential) is $2V$. At the same time the peak voltage with respect to local "ground" (including the symmetry plane) is only $\pm V$, thereby allowing larger voltages in the differential mode.

Now the initial trigger is applied to the switch (on the symmetry plane) between the two halves. If desired, one or more switches on each half near the "center" of the Marx can also be triggered at the same time. For a given number of Marx stages (say 2N) the erection wave propagates simultaneously up each half, thereby lowering the erection time. The remaining spark gaps can be untriggered so that the erection wave overvolts successive gaps. Alternately, one can have signals from other positions on the Marx trigger successive gaps (e.g., [4]). For a differential Marx generator one can use signals from the plus side trigger gaps on the minus side, and conversely. A simple form of this is illustrated in Fig. 2.1. This has the potential advantage that, if one side is erecting facter than the other, it sends trigger signals to the other side to help it "catch up". As one goes along the Marx generator away from the initial triggering position, the voltages become progressively larger (after erection). So one may wish to make the impedances in the cross-triggering circuits also progressively larger. Spacing of capacitors from the symmetry plane may similarly progressively increase.

The cross-triggering scheme can also be made more elaborate by going from gap n on one side to gap m on the other with $|n-m|$ chosen as various integers, analogous to the circuits in [4]. Note that high-impedance connections to local ground are also needed to set the initial zero potential.

Also shown in Fig. 2.1 is a possible differential peaking or transfer capacitor between the Marx generator and the load. This can be connected to the load through two switches, but, if the gaps are self breaking, there may be a significant difference in the switch closure times. One may then wish to trigger both switches to close at the same time. (Another possibility is to use a transformer with a single self-breaking switch in the center of the primary.)

Note that the charging circuits are not indicated. There are various possibilities in this regard as discussed in [5]. An interesting possibility in this regard is parallel charging of the capacitors through individual LR ciruits for faster charging.

Other symmetries for a differential Marx generator are also possible [8]. One can envision spirals and various kinds of screw symmetry (translation and rotation). For example one might have a double helix like the DNA molecule, with the cross-triggers taking the place of the A, G, C, and T molecules.

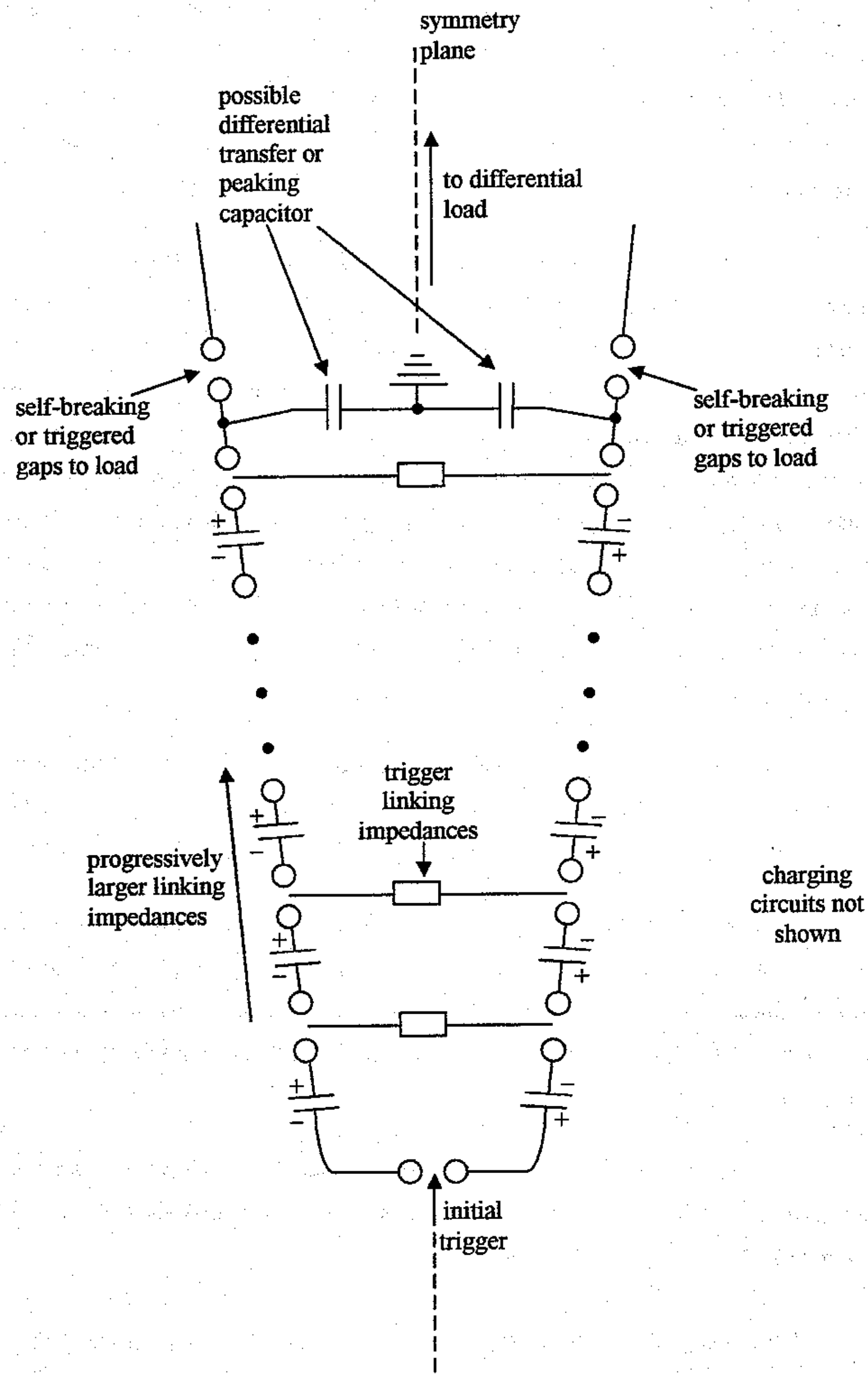

Fig. 2.1 Differential Triggered Marx

3. Concluding Remarks

We then have many possibilities for the design of differential Marx generators. Different applications may suggest different forms. There also are many complexities such as various parasitic impedances which need to be considered in arriving at optimal designs.

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