Available online at www.sciencedirect.com
ScienceDirect
Journal of Electrical Systems and Information Technology xxx (2016) xxx–xxx
www.elsevier.com/locate/jesit

Generation of sub-nanosecond pulses using peaking capacitor

Madhu Palati [a,*], Ritu Agarwal [b], Archana Sharma [b], Nagabhushana G.R. [a]

[a] *Dept. of EEE, SET, Jain University, Jakkasandra Post, Karnataka 562112, India*
[b] *Energetics and Pulse Power Section, APPD, BARC, Mumbai, Maharashtra 400085, India*

Received 16 December 2015; received in revised form 2 July 2016; accepted 3 October 2016

Abstract

This paper discusses the analysis, simulation and design of a peaking circuit comprising of a peaking capacitor, spark gap and load circuit. The peaking circuit is used along with a 200 kV, 20 J Marx generator for generation of sub-nanosecond pulses. A high pressure chamber to accommodate the peaking circuit was designed and fabricated and tested upto a pressure of 70 kg/cm^2. Total estimated values of the capacitance and inductance of the peaking circuit are 10 pF and 72 nH respectively. At full charging voltage, the peaking capacitor gets charged to a peak voltage of 394.6 kV in 15 ns. The output switch is closed at this instant. From Analysis & Simulation, the output current & rise time (with a matched load of 85 Ω) are 2.53 kA and 0.62 ns.

Keywords: Marx generator; Peaking capacitor; Rise time; Prepulse-current; Inductance; Capacitance

1. Introduction

In certain applications like high power microwaves (HPM), pulsed laser drivers, etc., very fast rise times – in the sub-nanoseconds range – are required. It is not possible for generation of such ultra-fast pulses by directly using a Marx generator even after reduction of the internal inductance to the practically realizable limits. Therefore, in addition to a Marx generator, a peaking circuit arrangement has been developed (Sundarajan et al., 2005; Prabaharan and Shyam, 2015; Holt et al., 2009) and used (Kekez and Liu, 1994; Cadilhan et al., 2008; Schilling et al., 1995). The peaking circuit comprises of a very low value-low inductance capacitor, a peaking spark gap switch & the load circuit.

The design, development and work carried out on the Marx generators along with peaking circuit for generation of fast current pulses, by the earlier researchers are briefly presented below:

Sundarajan et al. (2005) designed & developed a 600 kV Marx generator. Without and with peaking circuit, the rise times were 70 ns and 50 ns respectively. Prabaharan and Shyam (2015) developed a peaking capacitor and used with Marx generator. Rise time of 500 ps is calculated from the FFT peak frequency. Holt et al. (2009) used a peaking circuit

* Corresponding author.
E-mail address: mfmadhu@gmail.com (M. Palati).
Peer review under the responsibility of Electronics Research Institute (ERI).

ELSEVIER Production and hosting by Elsevier

http://dx.doi.org/10.1016/j.jesit.2016.10.010

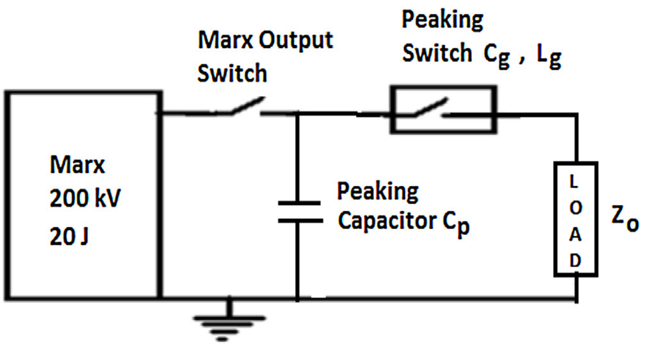

Fig. 1. Schematic diagram of Marx with peaking circuit.

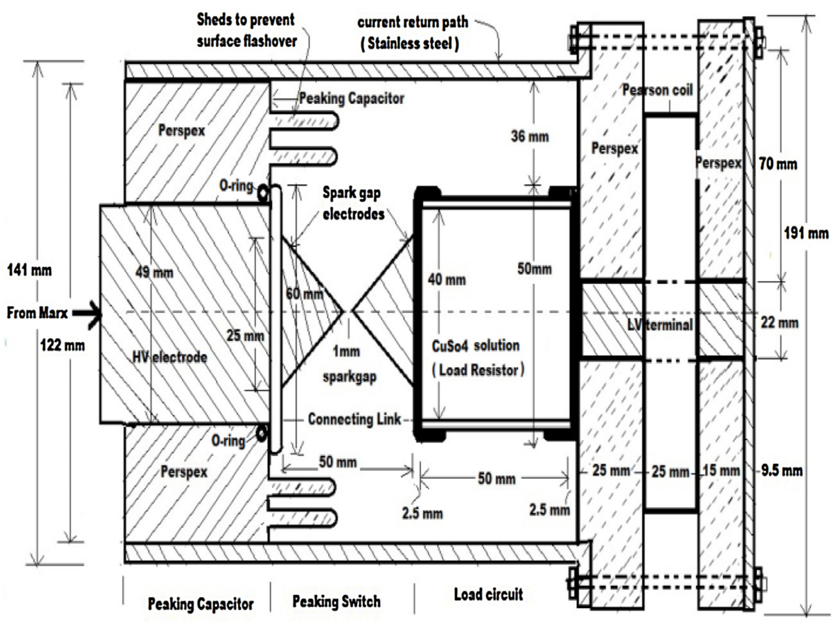

Fig. 2. Schematic of peaking circuit along with load.

to the output of the Marx and obtained a rise time of 7.6 ns. Kekez and Liu (1994) worked on a 600 kV, 60 J Marx generator with peaking circuit. Without and with peaking circuit the rise times were 3.34 ns and 0.4 ns respectively. Schilling et al. (1995) presented a 12 stage, high voltage Marx generator with a transfer capacitor and low inductance peaking capacitor. The output voltage and rise time were 970 kV and 8.6 ns respectively.

The schematic diagram of a peaking circuit is shown in Fig. 1, C_P is the peaking capacitor. The peaking-switch is a spark-gap and Z_0 is the load impedance, usually matching with the characteristic impedance of the peaking circuit. Initially the peaking switch is open. The Marx is charged to the desired voltage and discharged into the very low inductance peaking capacitor C_P. The voltage across the peaking capacitor is nearly twice the no-load output voltage of the Marx due to transient behaviour of RLC circuit having low R. Here, L is the inductance of the Marx. When the voltage across the peaking capacitor reaches the peak value, the peaking switch (which is a spark gap) sparks over. The peaking capacitor discharges into the load with a very fast rise time and short duration.

2. Design of peaking circuit

The schematic diagram of the peaking circuit along with load is shown in Fig. 2. The main component in a peaking circuit is a high voltage capacitor. It is of low capacitance value, with an extremely low inductance. The common