# Protection of Load through Ferrite Beads Using Marx Generator

**Aman Jain[1], Manish Pratap Singh[2], Apoorv Shankar[3], Vikram Kumar[4]**

[1]*B-26, Manavsthali Apartments, Vasundhara Enclave, Delhi-110096*
[2]*B-66/445, HWP Colony, Rawatbhata, Via Kota, Rajasthan-323307*
[3]*D1-602, BPCL Colony, Sector-56, Noida, UP-201301*
[4]*JSS Academy of Technical Education, Noida, UP*

## ABSTRACT

***In this paper, two ferrite filters were designed. These filters were tested on a spectrum analyser. Also, they were tested with a Marx Generator (5kV-50kV). These filters showed efficient capability to protect the load from any unknown surge/spark.***

## 1. INTRODUCTION

In 1989, Michael F. Stringefellow and John M. Wheeler invented a *surge suppression circuit* for high frequency communication networks, having a primary line and a ground line. It included a gas tube connected between the primary line and ground line, a bi-directional avalanche diode and one or more ferrite beads connected in series between the primary line and ground line, and a metal oxide varistor connected in series in the primary line.

In 2012, J. L. Kotny, X. Margueron and N. Idir introduced a high-frequency modelling method of the coupled inductors used in electromagnetic interference (EMI) filters. These filters are intended to reduce conducted emissions generated by power static converters towards the power grid.

The identification of the model parameters was based on the experimental approach. Simulation results of the proposed model were compared to the experimental data obtained using the specific experimental setup. These results made it possible to validate the EMI filter model and its robustness in a frequency range varying from 9 kHz to 30 MHz.

In 1924, Erwin Otto Marx described an electric circuit called *Marx generator*. Its purpose is to generate a high-voltage pulse from a low-voltage DC supply. Marx generators are used in high energy physics experiments, as well as to simulate the effects of lightning on power line gear and aviation equipment. The circuit generates a high-voltage pulse by charging a number of capacitors in parallel, then suddenly connecting them in series.

***Experimental Setup 1***


**Fig. 1: Block Diagram Representation of Ferrite Filter Circuit**

**Configuration 1:** Single ferrite bead with two wound wire configuration of ferrite beads connecting the positive terminal of function generator with one end of a wire on the bead and connecting the other end of the other wire to the positive terminal of the CRO such that the ground of function Generator and CRO were shorted along with the remaining ends of the two wires.

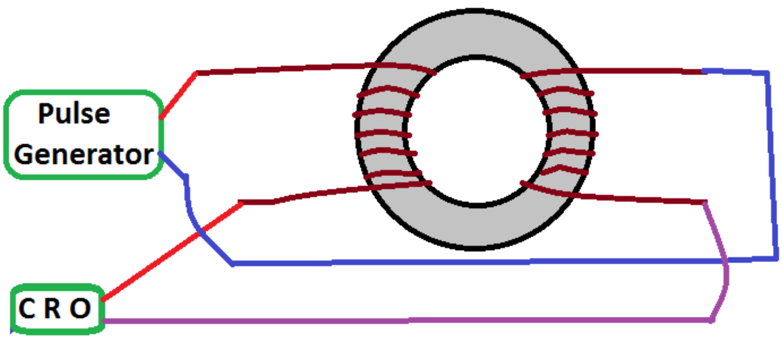


**Fig. 2: Single ferrite bead with two wound wire.**

**Configuration 2:** Tested the configuration of ferrite beads wherein one ferrite bead was connected between the positive ends and the other connected between the ground ends of the function generator and CRO.

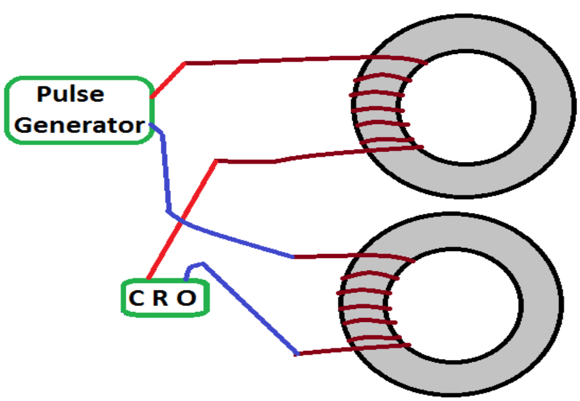


**Fig. 3: Single wire wound two ferrite beads in series.**

***Experimental Setup 2***

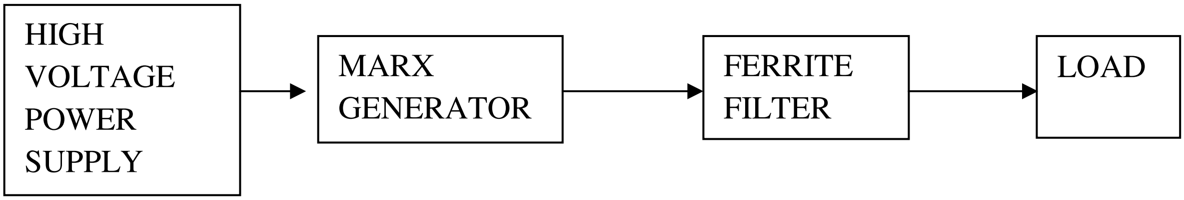


**Fig. 4: Block Diagram Representation of Setup to Test Filter Configurations**

## 2. DESCRIPTION

High Voltage Power Supply: It is a small current high voltage power supply consisting of a 450v inverter with an 18 stage voltage multiplier to get an output of about 7kV.

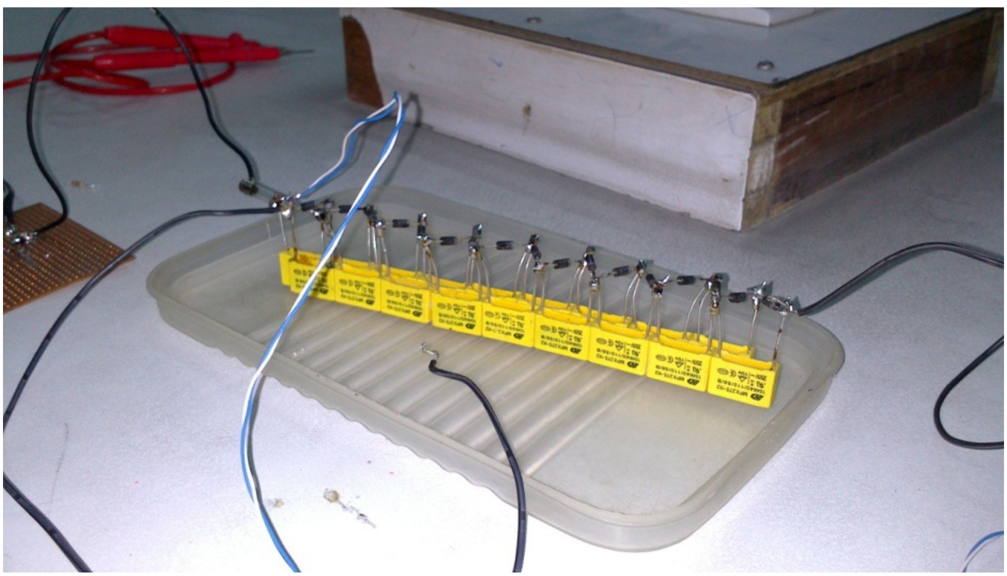

**Fig. 5: High Voltage Power Supply**

Here, the capacitors used are 100nF 400V film capacitors physically arranged like a ladder and 18 diodes connected in series. Supply from mains is first connected to 2MΩ resistance to limit the current value to a minimum amount (0.11 µA). A 0.5mA fuse is connected for protection of the circuit.

Marx Generator: Output from the power supply (7kV) is connected to the Marx generator. It is a park generator consisting of 10 RC stages which are charged in parallel and discharged in series thus producing a high voltage spark at each spark gap simultaneously.

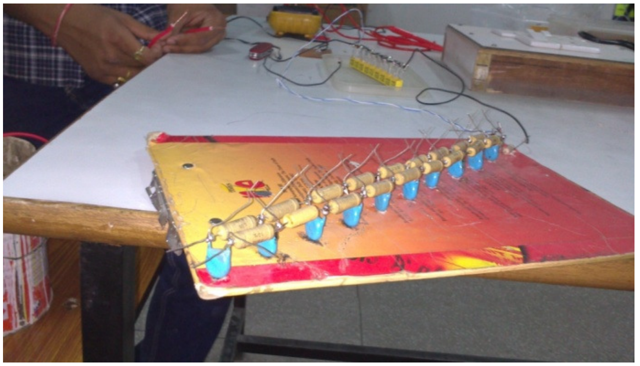

**Fig. 6: Marx Generator**

Here 1MΩ, 2W, 500V carbon film resistors and 1nF, 4kV ceramic capacitors are used as RC pairs. Also, two 4.7M, 350kV metal glazed resistors are used at the input side. These resistors have a ballasting effect. They are used to prevent a continuous arc forming across the first gap, thus preventing further firing of the Marx generator.

Ferrite Filter: Two configurations of ferrite filters are considered. These two are described above. The spark from the spark gap is passed through this filter to the load.

Load: This is a simple circuit consisting of a bulb charged by a simple battery.

**Result:** In experimental setup 1 (Fig. 1) the input from frequency generator is passed through the two configurations of ferrite filters and the result is seen at CRO.

When configuration 1(shown in Fig. 2) is used the CRO shows attenuation at high frequencies which is maximum at 12.29 MHz (as shown in Fig. 7).When configuration 2 (as shown in Fig. 3) is used the CRO shows attenuation at high frequencies which is maximum at 12.18 MHz (as shown in Fig. 8).

**Fig. 7: CRO output at 12.29 MHz for configuration 1**

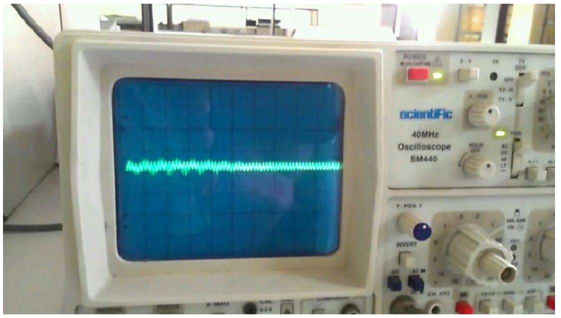


**Fig. 8: CRO output at 12.18 MHz for configuration 2**

In experimental setup 2 (Fig 4) a Marx generator produces sparks through spark gaps. It is supplied with a very high voltage dc supply of 5kV. The sparks produced are thrown on the test circuit (load) through ferrite beads which acts as a filter.

The result of this setup is summarised below in Table 1.

**Table 1: Summary of final result**

| POWER SUPPLY [kV] | MARX GENERATOR [ kV] | FILTER | LOAD PROTECTION |
|---|---|---|---|
| 5 | 50 | Configuration 1 | Yes |
| 5 | 50 | Configuration 2 | Yes |

## 3. CONCLUSION

Thus the two ferrite filters efficiently protected the load from the spark thus confirming that ferrite beads can be used in electromagnetic compatibility applications.

There are various other fields where these filters can be used, including energy management systems, computers, automatic lightning, AM radio equipment, factory automation equipment, implantable medical devices, military/space electronic modules, radio controls, telecommunication, television and monitors and various lab equipments.

## REFERENCES


[1] Stringefellow F. Michael, Wheeler M. John *Surge suppression circuit for high frequency communication networks* US Patent 1992; 5,124,873

*[2]* Kotny L. J, Margueron X, Idir N *High-frequency model of the coupled inductors used in EMI filters* IEEE Transactions on Power Electronics, 2012; Volume: 27 Issue: 6

**[3]** E. Kuffel, W. S. Zaengl, J. Kuffel *High voltage engineering: fundamentals*, Newnes 2000 ISBN 0-7506-3634-3, pages 63, 70