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Analytical and Experimental Studies on a Fast UWB Pulse Generating System

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Abstract— **With the advent of Ultra Wide Band (UWB) technology, several areas of applications have been opened. The UWB based impulse radiating antenna is based on radiation of an intense short duration Electro Magnetic (EM) pulse in a desired direction. Important subsystems of such UWB radar are the short pulse generator or in short 'Pulser' and a high bandwidth high gain antenna. Several researchers have developed and experimented on the UWB pulse generating system and studied the switch characteristics in particular. [1] This paper presents the developmental efforts for a 30 kV sub nanosecond UWB pulse source and a Half Impulse Radiating Antenna (HIRA) based radiating system. One of the basic intentions was to obtain fast rise time and the least jitter. Parametric analysis of simulated HIRA based UWB system with variation of angle between TEM feed transmission lines is carried out. Results of the realized UWB system for optimized rise time and jitter are also presented.**

Keywords- Ultra Wide Band (UWB), Pulser, Half Impulse Radiating Antenna (HIRA), Transverse Electro Magnetic (TEM)

I. INTRODUCTION

In order to obtain the necessary bandwidth consistently, it is essential to realize the UWB system with a fast rise time and least jitter. In the present work, the influence of the switching gas medium and the gas pressure for a range of switching voltages are experimented. It is also necessary to obtain higher field intensities in the far region of the UWB system. Hence in addition to the fast rise time it is also necessary to have a better antenna feed. In the present configuration a tapered conical TEM transmission line fed HIRA antenna is proposed. Radiation performance of the UWB system is a function of the antenna feed geometry. Reflected waves from the antenna see an aperture blockage due to the TEM feed lines. Aperture blockage and hence the far region electric field as a function of the variation of angle between the TEM feed lines wrt antenna axis is studied by modeling. CST simulation was carried out for a double exponential voltage pulse input. Pulser performance was measured for the best rise time & jitter.

II. MODELING, REALIZATION AND THE EXPERIMENTAL RESULTS

The realized UWB system consists of a mineral oil based compact coaxial capacitor and a pressurized gas switch. CST modeling of the HIRA as depicted in Table. 1 shows that for the variation of angle of TEM feed line wrt the vertical from 60° to 30° there is continual improvement in the radiated far electric field. The optimized angle was found to be 30°. The realized UWB system shown in Fig. 1 was experimented with

Table 1 : Effect of feed angle variation on peak radiated field

Distance from Antenna (m)	Peak radiated field at various feed angles wrt antenna axis (V/m)	
	45°	30°
1.5	405	651
3	223	303
4	100	126

various switching gases such as air, N_2 and SF_6 and different pressures to obtain the least rise time and jitter.

Figure 1. HIRA based UWB system, gas switch and test set up developed

Rise time measurements of the pulser output voltage were carried out by measuring the radiated field using a D dot sensor of 1.5GHz bandwidth and a Tektronics 16GHz oscilloscope. As depicted in Table 2, though the rise time was the best in case of pressurized SF_6 gas as switching medium, jitter performance was different at low and high pressures. At low pressures, jitter with N_2 was lower than that of the SF_6 gas as the switching medium.

Table 2 : Rise time performance of the 30kV system

Gas type	Rise time in ps at different gas pressures	
	1.5 bar	3 bar
Dry air	1500	925
N_2	1100	845
SF_6	900	620

III. CONCLUSION

i. Modeling results show that aperture blockage is the least and hence better performance is achieved when feed angle is reduced upto 30°. At angles less than 30° performance doesn't improve rather reduces due to high impedance mismatch.

ii. The best rise time was obtained in the case of switching gas SF_6 at 3 bar. Actual rise time obtained could be still better as the D dot sensor used had a limited bandwidth of 1.5GHz.

iii. Switching jitter is lesser in SF_6 at high pressures but at low pressures it is relatively more than air and N_2 due to the possible scavenging of electrons in the electronegative SF_6.

REFERENCES

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