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Analysis of EMI Effects on Attenuator Circuit

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Abstract: When electromagnetic interference takes place at the input of attenuator circuit which is made up of resistors it can cause operation variation. This work presents evaluation of the EMI effects in different types of attenuator circuits by applying a range of EMI signals varying from 5MHz-500MHz at constant magnitude of 100mV in series along with the 1 KHz/10V original input signal. The EMI effects on the test attenuator circuit of different types are predicted using ORCAD in terms of total job time, time step and output waveform. All the results compiled in the paper are simulated from the same. For easier understanding Bar graph is shown and line graph are shown.

Keywords: Electromagnetic Interference, Electromagnetic wave propagation, Attenuator, Types of attenuators.

I. INTRODUCTION

Electromagnetic interference also called radio frequency interference (RFI) is a disturbance that affects an electrical circuit due to either electromagnetic conduction or electromagnetic radiation emitted from an external source. The fundamental concept of electrical and electromagnetic interference involves an emanating source and an affected device or system [1-4]. The transfer of energy between systems can occur through radiation, conduction, or induction. The actual transfer of energy is facilitated respectively through a transmission path, conductive path, or through magnetic coupling [5-9]. The interference that affects wireless communication links is typically the result of radiated or conductive energy transfer. The condition of a conductive affect occurs when the signal is picked-up by a conductor attached to the affected system [10]. Several studies related to EMI effects on electronic devices and circuits have been reported in the literature and EMI effects on Passive circuit elements such as resistor and the circuits containing these components have been investigated and analysed by experimental and simulation studies.

The results of these studies indicate that EMI may cause significant changes and incorrect operation of electronic circuits[11-16]. The increasing demand and dependence on the use of electromagnetic transmission systems for information technology applications has enabled revolutionary communications capabilities to include cordless communication devices, wireless networking, and satellite communication systems[17-24]. As the number of these devices increases, there is an increase in electromagnetic radiation within the segments of the electromagnetic spectrum in which these systems operate[18-26]. These emissions have the potential to interfere with the normal operation and function of electronic communication links and systems. In this paper, the EMI effects on the different types if attenuators are investigated with the utilization of simulator ORCAD, with interesting results in terms of Time step, Total job time and output waveform.

Table 1: EMI Signals Used At Different Frequencies for Different Type Of Ateenuators.

Type of attenuators	Input signal	EMI Signal Frequency range	EMI signal Amplitude
Pi, L, O, Bridge, Balanced Bridge Type attenuators	1KHz/10V	10KHz-500MHz	100mV

II. TEST CIRCUIT

An attenuator is an arrangement of non inductive resistors used in an electrical circuit to reduce the audio or radio signal strength without introducing distortion. Attenuators can be designed to work as impedance matching networks. An attenuator is a passive microwave component which, when inserted in the signal path of the system, reduces the signal by specified amount. They normally posses a low VSWR (voltage standing wave ratio) which makes them ideal for reducing load VSWR in order to reduce measurement uncertainties. They are sometimes used to simply to absorb power, either to reduce it to a measurable level, or in the case of receivers to establish an exact level to prevent overload of following stages. Attenuators are devices used to adjust signal levels, to control impedance mismatch and to isolate circuit stages. Attenuators are linear, passive or active networks or devices that attenuate electrical or microwave signals.

A. *Pi Type Attenuator Circuit*:

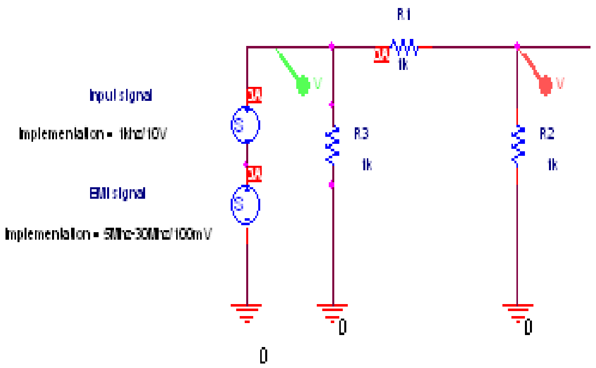
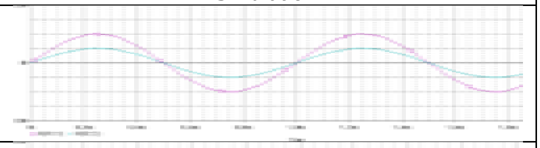
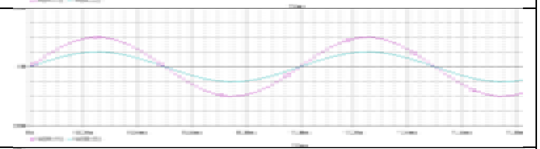
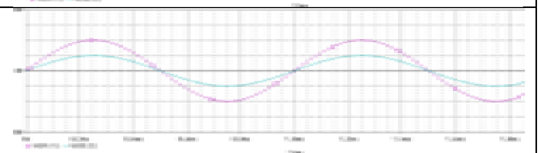
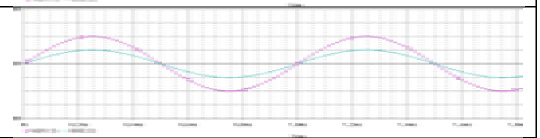
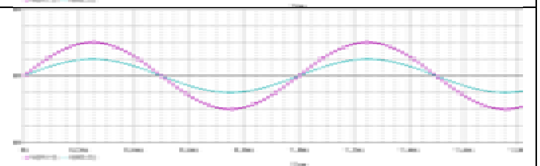
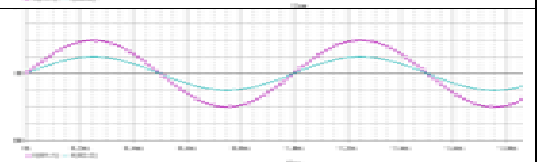
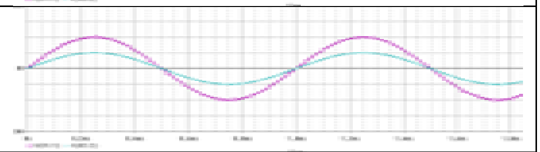
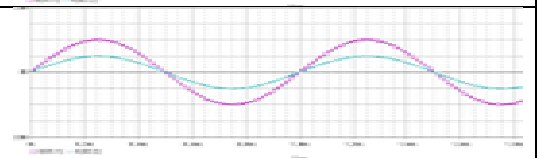
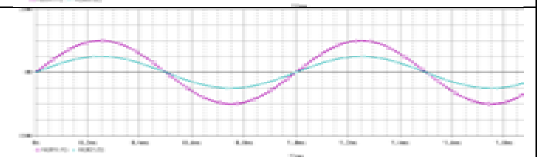
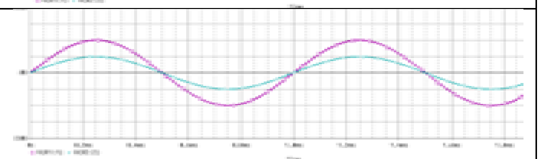
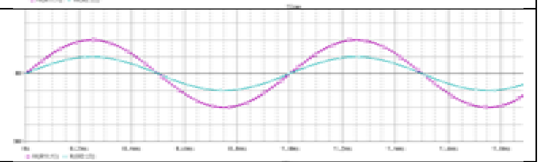


Figure 1: Pi type Attenuator circuit with 1 KHz/10V input signal and 5MHz-500MHz/100mV EMI signal

As shown in Figure 1 EMI signal having frequency range varying from 10 KHz-500MHz keeping magnitude constant of 100mV is injected in series with input signal of 1Khz/10V. As we can see from Figure 2 that as the frequency varies from 10 KHz to 500MHz total job time and time step keep on changing. At each frequency output waveform Voltage vs. Time is predicted and if EMI signal Frequency is increased beyond 500MHz the system is highly unstable. Output waveform is not much affected as the frequency increases but the system becomes unstable and cannot follow the input signal.

a. Experimental Result:

a) EMI EFFECTS WITH EMI SIGNAL AT FREQUENCY 300Hz-500MHz/100Mv

Input Signal	EMI Signal	Time Step	Total Job"Time, Sec"	Simulation
1KHz/10V	10KHz/100mV	$9.000e^{-06}$	0.17	
1KHz/10V	20KHz/100Mv	$4.500e^{-06}$	0.19	
1KHz/10V	40KHz/100mV	$2.250e^{-06}$	0.13	
1KHz/10V	100KHz/100mV	$1.079e^{-06}$	0.17	
1KHz/10V	500KHz/100mV	$179.2e^{-09}$	0.75	
1KHz/10V	1MHz/100mV	$57.22e^{-09}$	1.31	
1KHz/10V	5MHz/100mV	$12.55e^{-09}$	5.97	
1KHz/10V	30MHz/100mV	$2.051e^{-09}$	39.81	
1KHz/10V	50MHz/100mV	$2.395e^{-09}$	51.42	
1KHz/10V	100MHz/100mV	$520.4e^{-12}$	107.73	
1KHz/10V	500MHz/100mV	$20.49e^{-12}$	562.27	

B. *L Type Attenuator Circuit:*

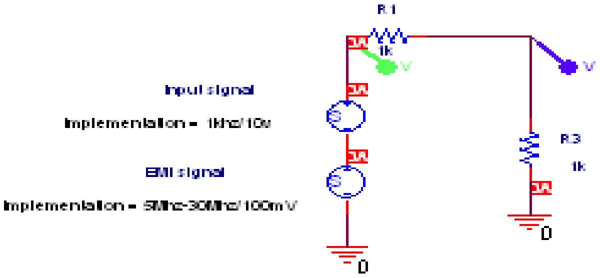
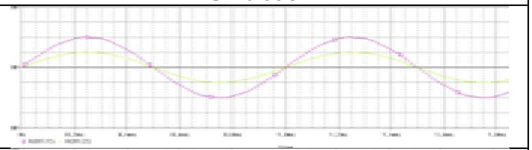
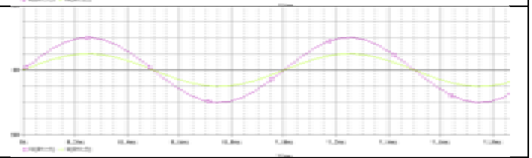
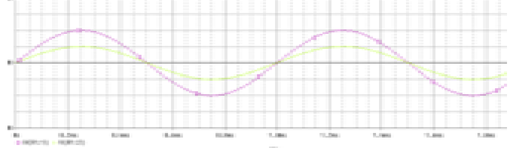
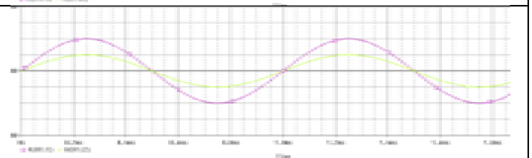
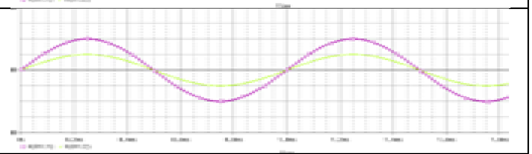
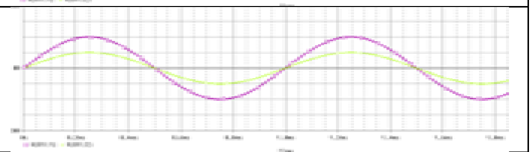
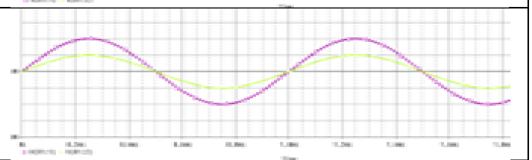
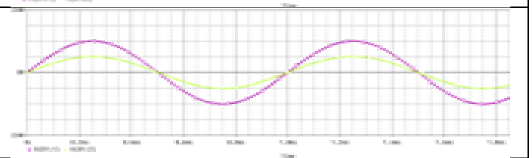
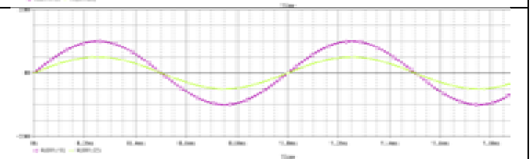


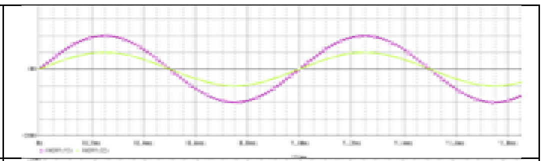
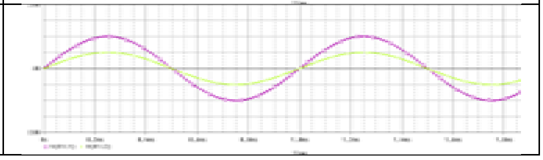
Figure 3: L type Attenuator circuit with 1KHz/10V input signal and 5MHz-500MHz/100mV EMI signal.

As shown in Figure 3 EMI signal having frequency range varying from 10 KHz-500MHz is injected in series with input signal keeping magnitude constant of 100mV is injected in series with input signal. As we can see from Figure 4 that as the frequency total job time and time step keep on changing but as the frequency is increased beyond 500MHz the system is highly unstable. At each frequency output waveform is predicted which shows the effect

b. *Experimental Result:*

b) EMI EFFECTS WITH EMI SIGNAL AT FREQUENCY 300Hz-500MHz/100Mv

Input Signal	EMI Signal	Time Step	Total Job"Time, Sec"	Simulation
1KHz/10V	10KHz/100mV	9.000e^{-06}	0.13	
1KHz/10V	20KHz/100Mv	4.500e^{-06}	0.16	
1KHz/10V	40KHz/100mV	2.250e^{-06}	0.13	
1KHz/10V	100KHz/100mV	1.079e^{-06}	0.33	
1KHz/10V	500KHz/100mV	179.2e^{-09}	0.78	
1KHz/10V	1MHz/100mV	57.22e^{-09}	1.42	
1KHz/10V	5MHz/100mV	12.55e^{-09}	6.22	
1KHz/10V	30MHz/100mV	2.051e^{-09}	39.94	
1KHz/10V	50MHz/100mV	2.395e^{-09}	54.44	

1KHz/10V	100MHz/100mV	$520.4e^{-12}$	109.97	
1KHz/10V	500MHz/100mV	$20.49e^{-12}$	529.48	

C. Type Attenuator Circuit:

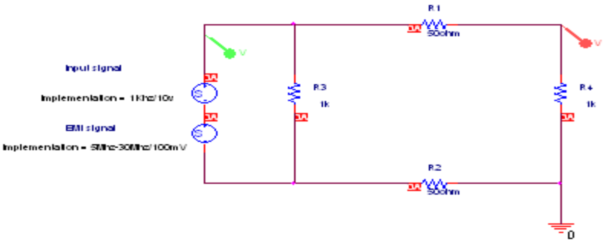
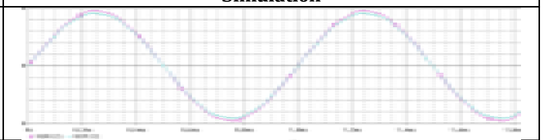
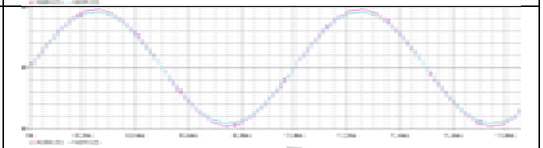
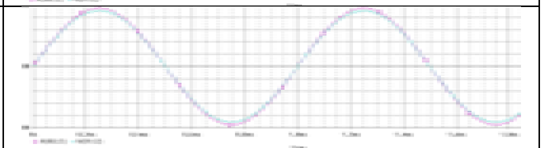
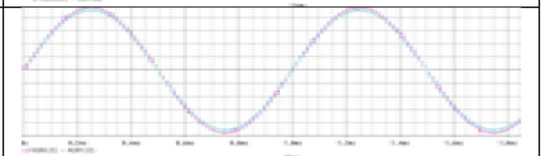
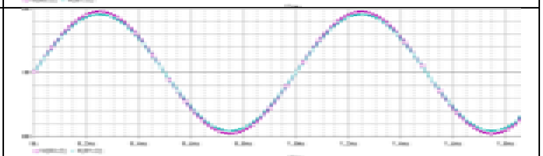
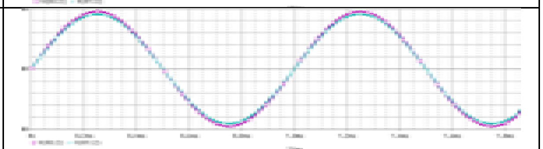
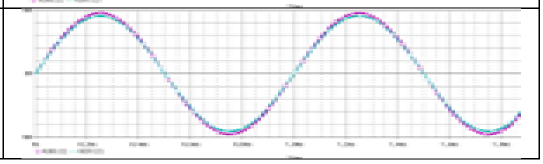


Figure 5: O type Attenuator circuit with 1KHz/10V input signal and 5MHz-500MHz/100mV EMI signal.

As shown in Figure 5 EMI signal having frequency range varying from 10 KHz-500MHz is injected in series with input signal keeping magnitude constant of 100mV. As we can see from Figure 6 that at each frequency output waveform is predicted but in this type of attenuator attenuation of the signal is done at a very small magnitude level and if EMI signal Frequency is increased beyond 500MHz the system is highly unstable. This attenuator has less attenuation magnitude as compared to other attenuators.

c. Experimental Result:

c) EMI EFFECTS WITH EMI SIGNAL AT FREQUENCY 300Hz-500MHz/100Mv

Input Signal	EMI Signal	Time Step	Total Job"Time, Sec"	Simulation
1KHz/10V	10KHz/100mV	$9.000e^{-06}$	0.11	
1KHz/10V	20KHz/100Mv	$4.500e^{-06}$	0.17	
1KHz/10V	40KHz/100mV	$2.250e^{-06}$	0.22	
1KHz/10V	100KHz/100mV	$1.079e^{-06}$	0.34	
1KHz/10V	500KHz/100mV	$179.2e^{-09}$	0.72	
1KHz/10V	1MHz/100mV	$57.22e^{-09}$	1.42	
1KHz/10V	5MHz/100mV	$12.55e^{-09}$	6.14	

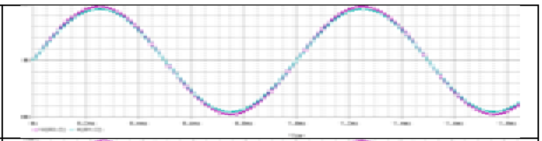
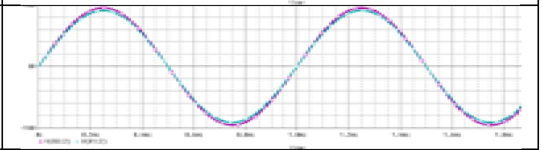
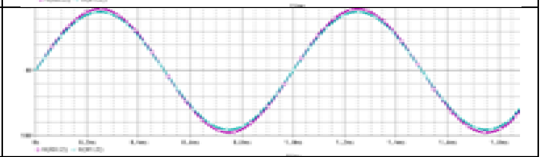
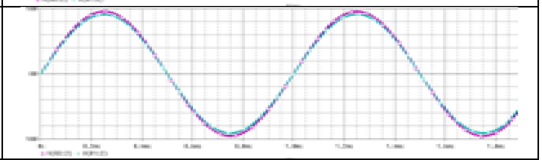
1KHz/10V	30MHz/100mV	2.051e-09	37.41	
1KHz/10V	50MHz/100mV	2.395e-09	54.39	
1KHz/10V	100MHz/100mV	520.4e-12	107.31	
1KHz/10V	500MHz/100mV	20.49e-12	555.81	

Figure 6 out put Wave form of O Type Attenuator

D. Bridge Type Attenuator Circuit:

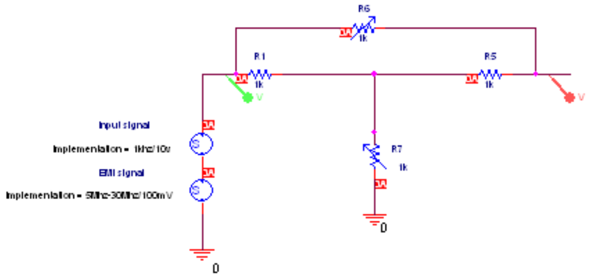
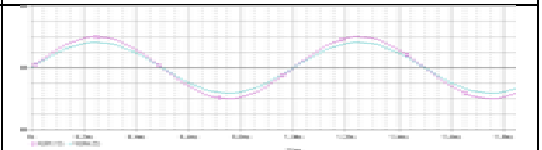
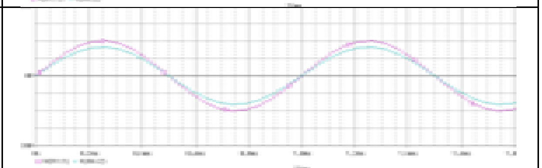
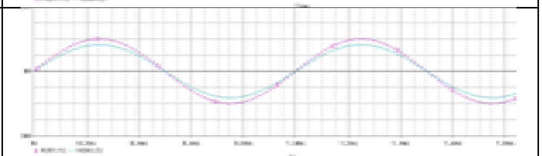
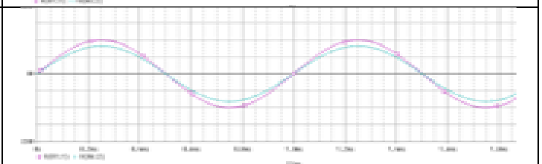
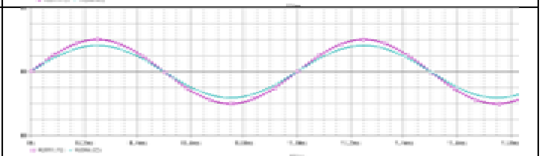


Figure 7: Bridge type Attenuator circuit with 1KHz/10V input signal and 5MHz-500MHz/100mV EMI signal

As shown in Figure 7 EMI signal having frequency range varying from 10KHz-500MHz is injected in series with input signal keeping magnitude constant of 100mV. As we can see from Figure 8 that as the frequency varies total job time and time step keep on changing and beyond 500MHz the system is highly unstable.

d. Experimental Result:

d) EMI EFFECTS WITH EMI SIGNAL AT FREQUENCY 300Hz-500MHz/100Mv

Input Signal	EMI Signal	Time Step	Total Job"Time, Sec"	Simulation
1KHz/10V	10KHz/100mV	9.000e-06	0.14	
1KHz/10V	20KHz/100Mv	4.500e-06	0.20	
1KHz/10V	40KHz/100mV	2.250e-06	0.23	
1KHz/10V	100KHz/100mV	1.079e-06	0.36	
1KHz/10V	500KHz/100mV	179.2e-09	0.77	

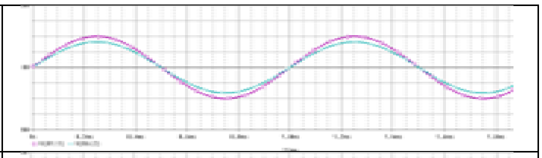
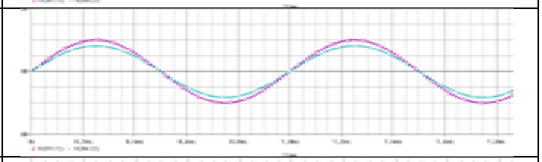
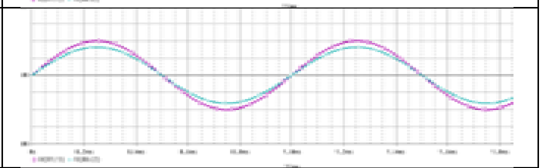
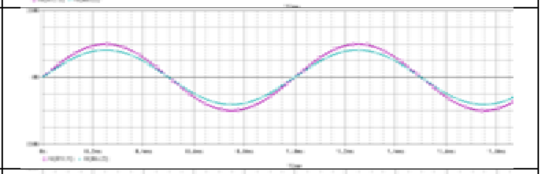
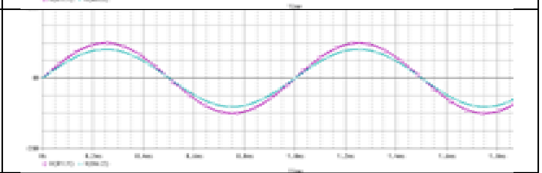
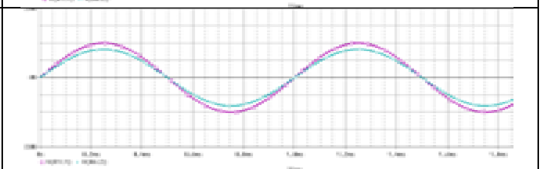
1KHz/10V	1MHz/100mV	57.22e^{-09}	1.34	
1KHz/10V	5MHz/100mV	12.55e^{-09}	6.39	
1KHz/10V	30MHz/100mV	2.051e^{-09}	39.03	
1KHz/10V	50MHz/100mV	2.395e^{-09}	66.38	
1KHz/10V	100MHz/100mV	520.4e^{-12}	113.97	
1KHz/10V	500MHz/100mV	20.49e^{-12}	552.59	

Figure 8: Output Waveform of Bridge Type Attenuator

E. Balanced Bridge Type Attenuator:

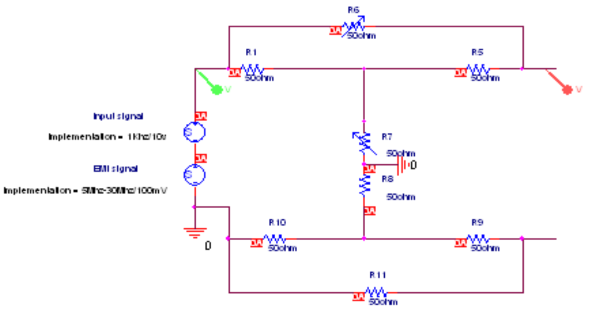
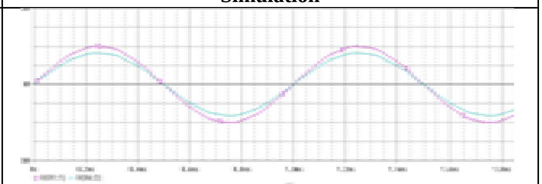
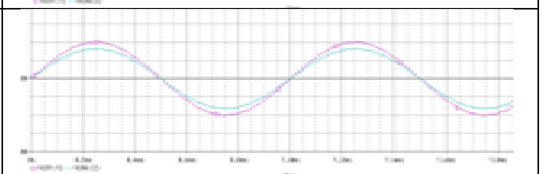


Figure 9: Balanced Bridge type Attenuator circuit with 1KHz/10V input signal and 5MHz-500MHz/100mV EMI signal

As shown in Figure 9 EMI signal having frequency range varying from 300Hz-500MHz/100mV is injected in series with input signal and it is clearly shown in Figure 10 that total job time and time step is varying but output waveform is not changing as the frequency increases. It is clearly shown that output waveform is predicted at each frequency along with time step and total job time in seconds.

e. Experimental Result:

e) EMI EFFECTS WITH EMI SIGNAL AT FREQUENCY 300Hz-500MHz/100Mv

Input Signal	EMI Signal	Time Step	Total Job"Time, Sec"	Simulation
1KHz/10V	10KHz/100mV	9.000e^{-06}	0.17	
1KHz/10V	20KHz/100Mv	4.500e^{-06}	0.17	

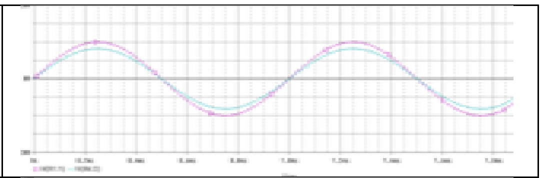
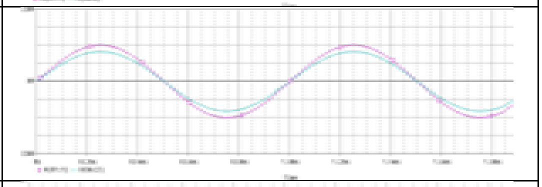
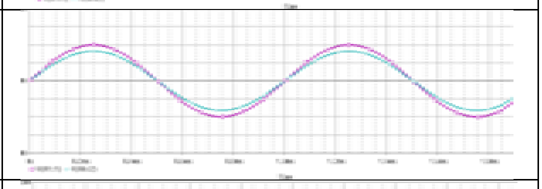
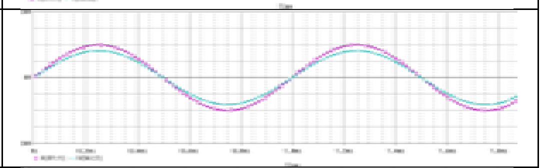
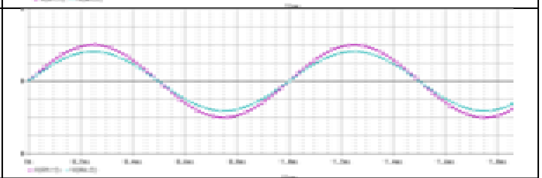
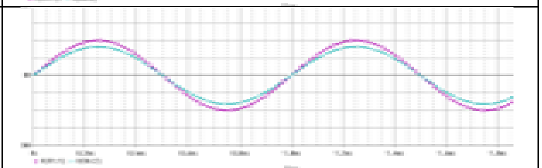
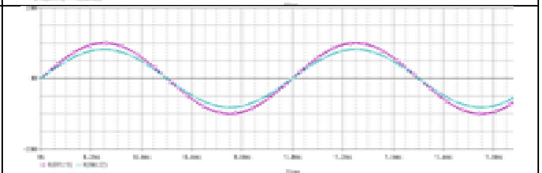
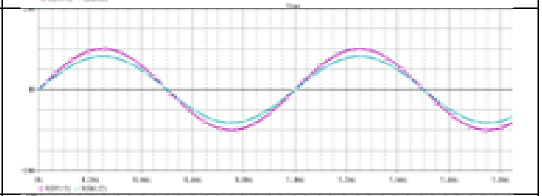
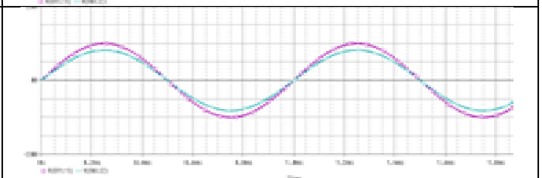
1KHz/10V	40KHz/100mV	$2.250e^{-06}$	0.13	
1KHz/10V	100KHz/100mV	$1.079e^{-06}$	0.34	
1KHz/10V	500KHz/100mV	$179.2e^{-09}$	0.78	
1KHz/10V	1MHz/100mV	$57.22e^{-09}$	1.41	
1KHz/10V	5MHz/100mV	$12.55e^{-09}$	7.23	
1KHz/10V	30MHz/100mV	$2.051e^{-09}$	47.31	
1KHz/10V	50MHz/100mV	$2.395e^{-09}$	56.55	
1KHz/10V	100MHz/100mV	$520.4e^{-12}$	118.64	
1KHz/10V	500MHz/100mV	$20.49e^{-12}$	577.33	

Figure: 10 Output Waveform of Bridge Type

COMPARISON

Table: 2 Comparison of Different Type of Attenuators

EMI Signal (100mV)	Type of Attenuators									
	Pi Type		L Type		O Type		Bridge Type		Balance Bridge	
	Time Setup	Total Job Time	Time Setup	Total Job Time	Time Setup	Total Job Time	Time Setup	Total Job Time	Time Setup	Total Job Time
10KHz	$9.000e^{-06}$	0.17	$9.000e^{-06}$	0.13	$9.000e^{-06}$	0.11	$9.000e^{-06}$	0.14	$9.000e^{-06}$	0.17
20KHz	$4.500e^{-06}$	0.19	$4.500e^{-06}$	0.16	$4.500e^{-06}$	0.17	$4.500e^{-06}$	0.09	$4.500e^{-06}$	0.14
40KHz	$2.250e^{-06}$	0.13	$2.250e^{-06}$	0.13	$2.250e^{-06}$	0.22	$2.250e^{-06}$	0.19	$2.250e^{-06}$	0.13
100KHz	$1.079e^{-06}$	0.17	$1.079e^{-06}$	0.33	$1.079e^{-06}$	0.34	$1.079e^{-06}$	0.28	$1.079e^{-06}$	0.33
500KHz	$179.2e^{-06}$	0.75	$179.2e^{-06}$	0.78	$179.2e^{-06}$	0.72	$179.2e^{-06}$	0.69	$179.2e^{-06}$	0.66
1MHz	$57.22e^{-06}$	1.31	$57.22e^{-06}$	1.42	$57.22e^{-06}$	1.42	$57.22e^{-06}$	1.31	$57.22e^{-06}$	1.47
5MHz	$12.55e^{-06}$	5.97	$12.55e^{-06}$	6.22	$12.55e^{-06}$	6.14	$12.55e^{-06}$	6.03	$12.55e^{-06}$	6.80
30MHz	$2.051e^{-06}$	39.81	$2.051e^{-06}$	39.94	$2.051e^{-06}$	37.41	$2.051e^{-06}$	40.83	$2.051e^{-06}$	36.16

50MHz	$2.395e^{-06}$	51.42	$2.395e^{-06}$	54.44	$2.395e^{-06}$	54.39	$2.395e^{-06}$	66.38	$2.395e^{-06}$	56.55
100MHz	$520.4e^{-06}$	107.73	$520.4e^{-06}$	109.97	$520.4e^{-06}$	107.31	$520.4e^{-06}$	113.97	$520.4e^{-06}$	118.64
500MHz	$20.49e^{-06}$	562.27	$20.49e^{-06}$	529.48	$20.49e^{-06}$	555.81	$20.49e^{-06}$	552.59	$20.49e^{-06}$	577.33

From the Bar Chart as shown in Figure 11 it is clear that total job time is going on increasing as the frequency increases but total job time of L Type attenuator is less than all other type of attenuators which means that EMI has less effect on L type attenuator comparative to other type of attenuators. It has also been observed that balanced bridge type attenuator has maximum job time means it is much affected from EMI as we increase the frequency. Bridge type and O type attenuators have same total job time whereas pi type attenuator has more total job time than L,O and Bridge Type Attenuators.

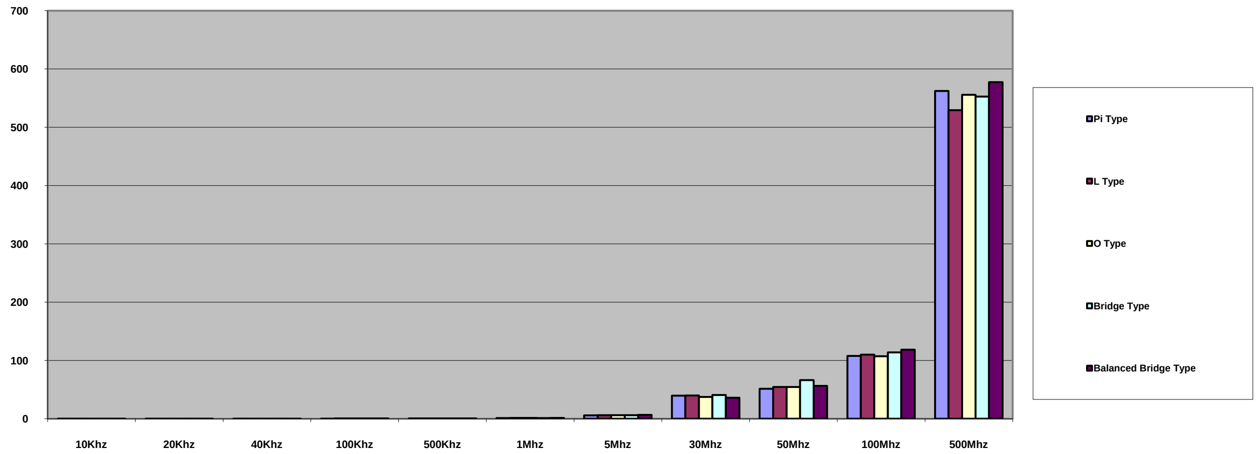


Figure: 11 Total Job time of Different Type of Attenuators

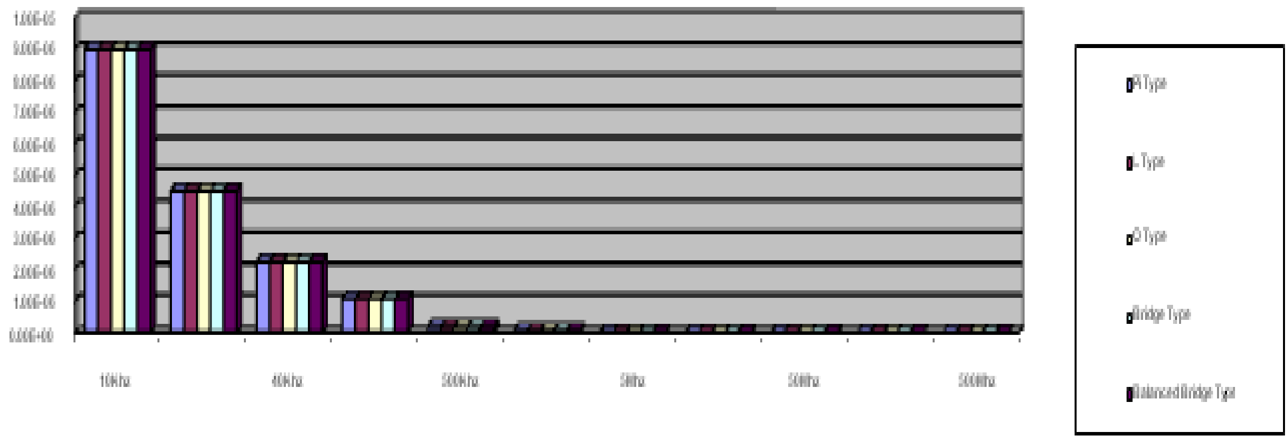


Figure: 12Time Setup of Different Type of Attenuators

From Bar chart as shown in Figure 12 it is clear that the time step of all the attenuators is same at different frequencies but it going on decreasing as we increase the frequency from 10KHz-500MHz/100mV.CONCLUSIONIn this paper the investigation of EMI effects on different type of attenuator circuits is analyzed and simulated. A detailed analysis is carried out for EMI signals used at different frequencies and Simulated results show that EMI can cause degradation of attenuator operation mostly beyond 30MHz/100mV in terms of total job time and time step but output is not much affected. Output of attenuator is more degraded when we increase the amplitude of EMI signal. In this paper, a comparison of different type of attenuators is carried out in terms of time step and total job time as shown in Table2. And it is shown in figure 11 that L type attenuator is taking less job time as compared to other attenuators under the influence of EMI signal and balanced bridge type attenuator has maximum total job time so it has more effect of EMI.

III. REFERENCES

[1]. Mandeep Kaur, Shikha kakar, Danvir Mandal, "Eletromagnetic Interference", Eletromagnetic Interference", 3rd International conference on Electronics Computer Technology, IEEE 2011, vol 4, pp.1-5

[2]. Mandeep Kaur, Danvir Mandal, "Analysis of EMI effects on Monostable Multivibrator",,IJCSET, vol 1 Issue 5, pp.194-199, June 2011.

[3]. Mandeep Kaur, Shikha kakar ,Danvir Mandal, "Analysis of EMI effects on 555 Timer", IJEEE, vol 4,no.1, pp.61-74, June 2011

[4]. O.Galip Saracoglu, Recai Kihe, "A Simulation Study on EMI Effects in Autonomous Chua's Chaotic Circuit",,IEEE, 2003

[5]. Graffi, S., Masetti, G. and Golzio, D., "New Macromodels and Measurements for the Analysis of EM1 Effects in 741

Op-amp Circuits", IEEE Trans. on EMC, vol. 33, no 1, pp. 25-34, 1991.

[6]. Florean, D., PineHi M. and Tomasin, P., "Analysis of RFI Effects in Voltage Regulator ICs: Measurement Techniques, Picking Capability, Prediction and Protection Methods", 2000 IEEE lnt. Symp. On EMC, Washington D.C., August 2000.

[7]. Florean, D., Marchiori, F., Pinelli M. and Tomasin, P.,"Analysis of EMI Effects in Op-Amp IC's: MeasurementTechniques and numerical prediction", 2001 IEEE Int. Symp. On EMC, Montreal, August 200 1.

[8]. F. Fiori, V. Pozzolo, "On the Effects of RF in Voltage Regulator Integrated Circuits", International Symposium on EMC, Zurich 1997.

[9]. F. Fiori, V. Pozzolo, "On the Effects of RF on Bipolar Integrated Circuits", International Symposium on EMC, Rome 1996.

[10]. H.-C. Tsai,, Investigation into Time and Frequency domain EMI induced noise in Bistable Multivibrator ,Progress In Electromagnetics Research, PIER 100, 327-349, 2010

