بسم الله الرحمن الرحيم

شبكة المعلومـــــات الجامعية

التوثيق الالكتروني والميكروفيلم

شبكة المعلومات الجامعية

جامعة عين شمس

التوثيق الالكتروني والميكروفيلم

﴿ قـــسـم ﴾

نقسم بالله العظيم أن المادة التي تم توثيقها وتسجيلها
علي هذه الأفلام قد اعدت دون آية تغيرات

يجب أن

تحفظ هذه الأفلام بعيداً عن الغبار

في درجة حرارة من 15 – 20 مئوية ورطوبة نسبية من 20-40 %

To be kept away from dust in dry cool place of
15 – 25c and relative humidity 20-40 %

بعض الوثائق الأصلية تالفة

بالرسالة صفحات

لم ترد بالأصـــل

MANSOURA UNIVERSITY

Faculty of Engineering

Dept. of Electronics Engineering,

and Elect. Communications

PROTECTION OF ELECTRONIC EQUIPMENT AGAINST NUCLEAR ELECTROMAGNETIC PULSE (NEMP)

By

Engineer: Hossam Abd El-Fattah El-Shiekh.

Air Defense Force

A Thesis

Submitted to the Faculty of Engineering

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Prof. Dr. Hamdi A. El-Mikati
Faculty of Engineering
Mansoura University,

Ass.Prof. Essam A. El-Diwany
Electronics Research, Institute
Cairo, Egypt

Dr.Mohamed K. El-Mahy
Armament Authority of the Armed Forces

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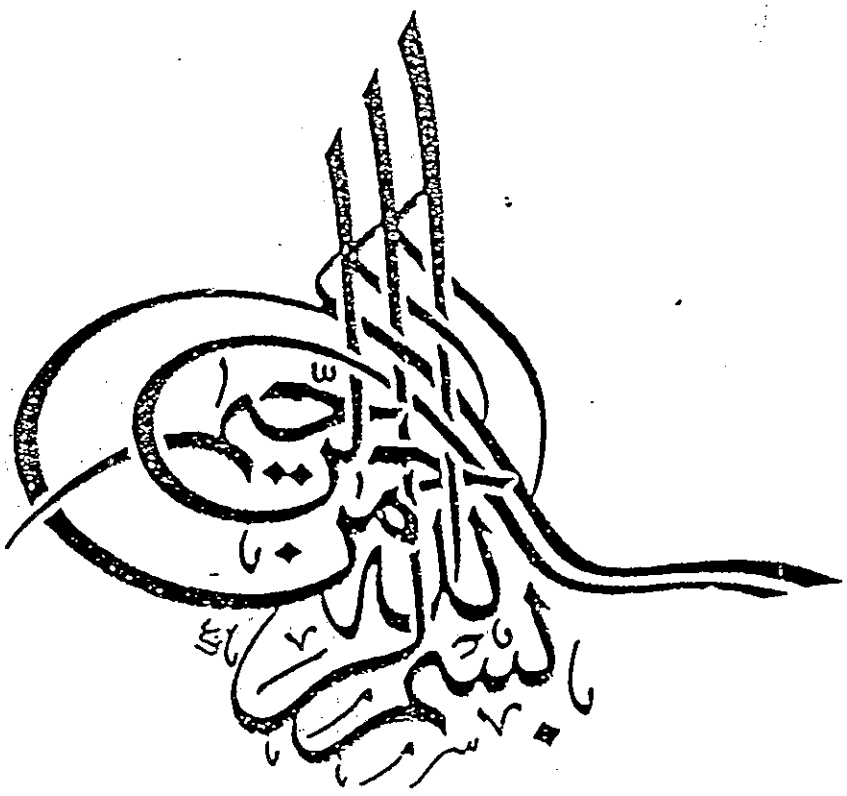

وقل اعملوا

فسيرى الله عملكم ورسوله والمؤمنون

صدق الله العظيم

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Abstract

The waveform of the large altitudes EMP includes an early pulse of high amplitude and short period, in addition to intermediate and late time pulses of progressively lower amplitudes and longer periods.

The NEMP can penetrate into systems through antennas, long and short transmission lines, and through apertures in shielded enclosures. Peak currents of thousands of amperes may be induced in conductors. NEMP induced currents and voltages may cause upset in digital electronics, temporary malfunction of circuits and sensitive component damage.

Protection against NEMP includes the use of metal shields around electronic systems, proper grounding, the use filters on lines and the use of surge suppressors such as zener diodes. varistors and gas discharge tubes .

Penetration of NEMP into shielded volumes containing apertures is investigated in the present work using the finite-difference time domain method .The characteristics of the penetrating field are considered for a cubic cavity with square and rectangular apertures. The resonant modes excited inside the cavity are determined through the FFT of the penetrating field. The effect of the cavity volume and aperture size on these modes and on the decay rate of the field inside the cavity is investigated. The dependence of the peak penetrating field on the dimensions of square and rectangular slots is considered in two cases, when the NEMP electric field is perpendicular or parallel to the slot. The effect of the aperture location is also considered. Finally, the current induced in a wire inside the cavity is investigated.

Contents

Introduction

Nuclear electromagnetic pulse (NEMP) is a high amplitude short duration electromagnetic pulse that originates from a nuclear burst. The high altitude EMP results due to the gamma radiation following the strong nuclear burst which causes atmospheric electrons to be freed, which in turn generate the EMP during their motion under the effect of the earth's magnetic field. The level of the resulting electric field is about 50 kV/m with a rise time of a few nanoseconds. The effects of EMP extend to an area of 500-800 km or even more in radius depending on the height and the power of burst. Its spectrum is concentrated below 100 MHz. Any conductor within the affected area of EMP will act as an antenna to pick up the electromagnetic pulse .The induced currents and voltages may cause malfunction or damage of electronic equipment within the affected area. It should be noted there are other types of EMP such as that resulting from near surface and under ground expositions. Emphasis in this Thesis, however high altitude EMP.

In the present work the basic aspects of the NEMP are presented including its generation, the characteristics of the EMP, its penetration into electronic systems, and the protection methods against EMP. The penetration of EMP into a shielded cavity is investigated using FDTD method .The characteristic of the penetrating field is studied under different conditions. The current induced in a wire located inside a cavity is also calculated. The thesis comprises four chapters followed by a conclusion as follows.

Chapter 1: Nuclear Electromagnetic Pulse Generation and Characteristics

The generated NEMP is presented at the early time, the intermediate time and the late time. These characteristics include the affected area, the field intensity, the pulse energy density and its spectrum.

Chapter 2: NEMP Penetration Modes and Effects

The modes of penetration of the EMP to the electronic and electrical systems are investigated. Such modes include direct penetration from aperture in shielded, through cables or transmission line and through antennas. The induced current amplitudes and waveforms are presented for the different cases. The effects of EMP on electronic circuits and components are discussed, which include circuit upset and

latch up and permanent component damage. The failure levels for different components are presented.

Chapter 3: The Protection Against the Nuclear Electromagnetic Pulse

The protection methods against EMP are discussed. These, methods basically include shielding, grounding, filtering and voltage limiting.

The roles of shielding in reflecting an incident wave and in attenuating the high frequencies due to the skin effect are presented. Penetration through apertures at high frequencies is highlighted. The principle of the waveguides below cut off is used for making ventilation apertures in shielded volumes. Penetration of the low frequency components of an EMP into a real shielded volume without apertures is also exposed.

Proper grounding is important in avoiding the induction of intense currents and potential differences in different circuit boards and cables.

Filtering is important in limiting the currents and voltages induced in conductors due to EMP outside the frequency band of interest of the circuit. The wide band nature of EMP and its high intensity causes the major difference in the design and the nature of the components used in the filters compared with the conventional filters.

Surge arresters, such as zener diodes, varistors and gas discharge tubes are used to limit the voltage incident on the susceptible circuit. Each of the limiting devices has its own characteristics including the limiting voltage, the energy dissipation capability, the speed and the devices capacitance, which limits its use at high frequencies. Combinations of these devices are appropriate to achieve optimal protection.

Other methods of network hardening and circumvention are also presented.

Chapter 4: Nuclear Electromagnetic Pulse Penetration through Apertures in Cavities

This chapter is concerned with the penetration of the nuclear electromagnetic pulse through apertures in cavities .A review is first given for the different factors affecting the penetrating field. Penetration through large and small slots is first presented in the frequency domain. The effect of the number of apertures on the field penetrating into the cavity is shown. Long apertures are also considered both when the incident electric field is perpendicular or parallel to the slot. The relation of the frequency of the incident wave on exciting certain cavity modes near or far from the resonance frequency is presented. The effect of radiation and absorption losses on the