



ELECTROMAGNETIC PULSEWEAPON TECHNOLOGY ALONG WITH EMP SHIELDING AND DETECTION METHODOLOGY

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ABSTRACT:

In the high technology condition, the weapon safety and survive capability is severely threatened by the complicated and changeable electromagnetic environment, especially for the electromagnetic field produced by HPM and ESD high rise current pulse. Electronic devices are gradually sensitive to the high electromagnetic pulse as the reducing characteristic size, increasing integrated degree, reducing power consumption, increasing working band and so on. It's significant to study the damage and failure mechanism of electronic devices under high power electromagnetic field (HPEM) either for the civilian use or for the military application. The damage effect of typical electronic devices including diode, transistor, and digital integrated circuits under lightning surge pulse and nano-second square pulse is studied in this article. The damage law of various electronic devices under different pulse width is obtained, and the damage and failure mechanism of each device under different pulse power is analyzed, and some defending suggestion is proposed in the end of the article.

KEYWORDS:

component; electronic device; lightning surge Pulse ;nanosecond square pulse; failure.

LITERATURE SURVEY:

1. **PummyRatna, Sachin Jain, J. Chattopadhyay** presented the design The Global Positioning System (GPS) based navigation system for air born application has RF receiver frontend exposed to external Electromagnetic Pulse (EMP) attack threat due to direct connectivity to GPS antenna. Damage to these LNAs or following digital circuitry and disruption in received data may cause catastrophic failure of the navigation system. A measurement study has been carried out to estimate the effect of EMP on GPS active antenna. Mitigation technology has been successfully developed and integrated at the front end without deterioration in the receiver sensitivity. This paper presents design of protection circuitry, RF and noise performance, EMP Test methodology and test results as per MIL-Std-461D for protected and unprotected systems **Mitigation Technique for High altitude Electro magnetic Pulse (hemp) For GPS Receiver (2014).**
2. **K. Omar, N. Graneau, M. Sinclair, B M Novac, I R Smith** Proposed an experimental programmed, leading to the development of a foil-flyer electromagnetic accelerator

(FFEMA), is being conducted at AWE. A high current pulsed power generator driving a foil-flyer is used to provide tailored impulse profiles into targets for testing material properties at high strain rates. This work has required the design and construction of both an experimental platform to conduct the experiments, named AMPERE, as well as the development of a number of computer models to predict the electrical and mechanical performance of the foil-flyer and its interaction with a target. **Foil-Flyer Electro-Magnetic Accelerator Initial Results From A New AWE Pulsed Power Generator (2011).**

3. **Carl E. Baum** presented the design in the beginning of 1960s, serious attention was paid to the nuclear electromagnetic pulse. This was later extended to conventional high-power electromagnetic sources/antennas. This paper reviews the history in which I played a central part, discussing the major programs, events, and players. The IEEE Transactions On Electromagnetic Compatibility (EMC) was one of the major fora for bringing this technology to the more general scientific/engineering EMC community. **Reminiscences Of High-Power Electromagnetics (2007).**
4. **C. E. Baum** presented the effort has gone into developing requisite technology for the nuclear electromagnetic pulse (EMP). In the late 1970s several important summary documents were published. The author updates this information to the present. It is noted that EMP has affected a set of related areas which can be collectively referred to as high-power electromagnetics (HPE). This includes direct-strike lightning, high-power microwaves (HPM), and some aspects of transient radar. **From The Electromagnetic Pulse To High-Power Electromagnetics (1992).**
5. **Yasushi Minamitani, Yuya Takeda, Sunao Katsuki, Hidenori Akiyama** presented the design in Nanosecond and sub-nanosecond high voltage pulses can provide new applications. A cancer treatment by an ultra-short pulse high electric field is one of them. High power pulsed electromagnetic wave has been proposed to apply the high electric field for that treatment. Therefore we are developing a high power burst pulse electromagnetic wave generator for bio-electrics application. In this work, we have measured the electric field generated by electromagnetic wave in water as a phantom experiment. The electric field generated by electromagnetic wave in water has been measured by an optical method. The optical method has employed the Kerr effect of water. This method can measure the fine electric field distribution at one time by the use of a laser. As a result, we have been able to measure focused electromagnetic wave electric field. This result has demonstrated that the optical method can measure the electric field generated by the electromagnetic wave **Measurement Of Electric Field Generated By High Power Burst Pulse Electromagnetic Wave In Water For Application To Bioelectrics (2016).**

1. INTRODUCTION:

It is of great significance to study the damage effect of the electronic devices under high power electromagnetic pulse in various areas, including electronics, information and communication, aerospace, and so on. It is known that the characteristic dimension of integrated circuits is developing following Moore's Law, and has reached very deep submicron level, ultra

deep submicron level and even nanometer level these years. Microelectronic device and integrated circuits as an absolute necessity in industry is gradually vulnerable under

electromagnetic circumstance, with the feature size smaller, wafer size larger, power consumption lower and operating frequency higher. On the other hand, the electromagnetic circumstance turns to be more and more complicated under the high advanced technology, except for pulse sources from nature such as the lighting electromagnetic pulse (LEMP), and the electrostatic discharge pulse (ESD), there are even more factitious electromagnetic pulse from communication devices, radar, and some kinds of electromagnetic pulse weapons, and so on. This complex and changeable electromagnetic circumstance especially for high power microwave severely threatens the safety and survival ability of numerous weapons and equipments, which are mainly consisted of large amount of microelectronic devices and different kinds of integrated circuits. In this case, to study the failure mechanism of electronic devices under high power electromagnetic pulse is certainly helpful for the anti electromagnetic pulse designs. Many researchers around the world have studied the damage and failure of diodes, transistors, and certain types of integrated circuits under ESD, high power microwave and other EMP not only with experimental method but also applying simulation methods. J. Smith from Rome Air Development Center studied the test of electronic devices under electromagnetic pulse in 1971, as in [1]. D.C. Wunsch and R.R. Bell proposed the method to determine the failure threshold of several types of diodes, transistors under pulsed voltage, as in [2]. R. Jenkins and D.L. Durgin discussed the failure of integrated circuits under EMP, as in [3]. Moreover, some researchers applied simulation methods to analyze the charge carrier and temperature distribution during the injection of different kinds of pulsed voltage or current. This article studies the failure of two types of transistors, two types of TTL and two types of CMOS under lighting surge pulse voltage as well as nanosecond square pulse voltage. Failure threshold of these devices is extracted, the distribution of the threshold is analyzed, and some suggestion of different devices to resist electromagnetic pulse is proposed.

2. MEASUREMENT

2.1 Sample Preparation

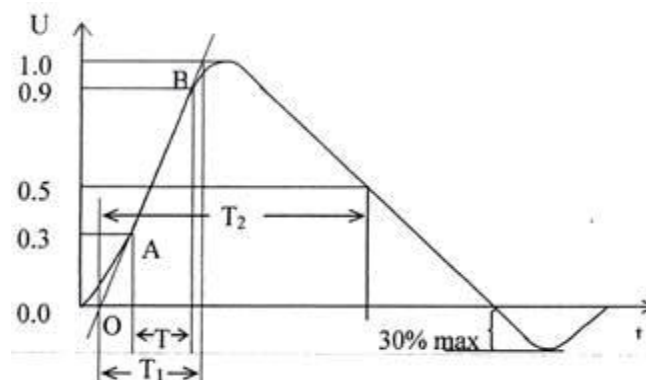
In this thesis, six types nearly 600 numbers of devices are used as the sample, including two types of transistors (S8050, 2SC3358), two types of TTL (74LS00, 74F02) and two types of CMOS (TC4001BP, 74HC32).

2.2 Pulse Source

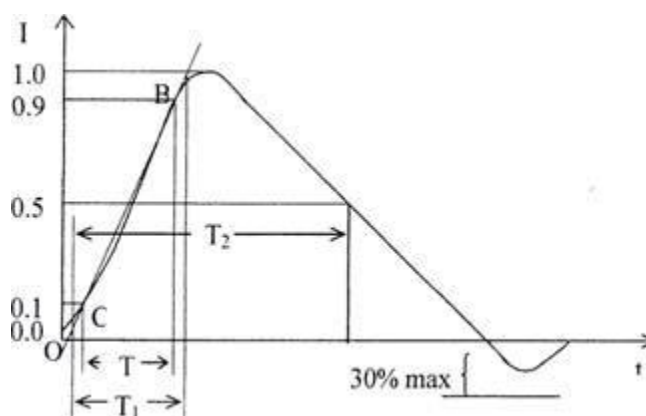
Two kinds of electromagnetic pulse are applied, which is lighting surge pulse and nanosecond square pulse, the pulse parameters.

2.3 Experiment System

The block diagram of experiment system used in the thesis. Different electromagnetic pulse is applied to the untested samples, oscilloscope DSC3001 is used for voltage and current measurement.



Fig(a) open circuit voltage, $T_1=1.2$ microseconds, $T_2=50$ microseconds



Fig(b) short circuit current, $T_1=8$ microseconds, $T_2=20$ microseconds

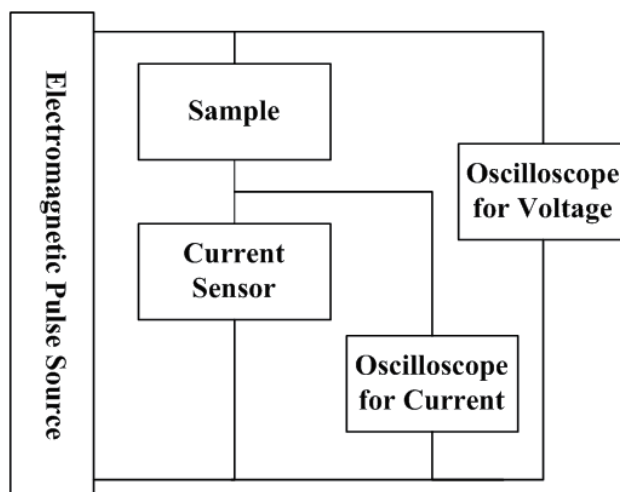


Fig 2.3 Block diagram of experiment system

2.4 Test Methodology

Prior to testing, each integrated circuit(IC) was characterized using XJ4822 transistor characteristic exhibit instrument and the logic test circuit to insure the parameter and function of these ICs met there specification. Every IC was then pulsed from a starting pulse voltage

using the step stress method, and a posttest characterization was run after every pulse injection to determine if the IC is failed. Every terminal of an IC is pulsed, and the terminal that has the lowest voltage is defined to be sensitive terminal, for which the failure voltage is defined to be the voltage threshold of this IC, it is the same with the power threshold and energy threshold.

2.5. Data reduction

Data reduction consisted of plotting the histogram of the energy threshold versus number of failures and the fit of power threshold versus pulse width under the square pulse.

The energy threshold is confirmed to follow normal distribution both experimentally and theoretically. Moreover, for pulse width in the range of 100ns to 10µs the failure power versus pulse width exhibits a linear dependence on a log-log scale indicating a power-pulse width relationship of the express

$$P=AtB \quad (1)$$

P stands for the failure power, A and B are constants

3. EXPERIMENTAL RESULTS

3.1 Lightning Surge Pulse

After applying lightning surge pulse, every terminal of each device presents different failure mode such as open circuit and short circuit. The energy threshold of each IC appears to be normally distributed, Fig. 3 is the histogram of energy threshold versus failure number of S8050 and 74LS00.

Table II gives the energy threshold and parameters of normal distribution.

3.2 Nanosecond Square Pulse

Nanosecond square pulse is applied to each device in a series of pulse width of 200/400/600/800/1000ns, the histogram of energy threshold versus failure number.

Table III gives the energy threshold and parameters of normal distribution of each device.

(a) S8050, average energy=3.94E-03J, standard deviation=1.99E-04

(b) 74LS00, average energy=4.17E-05J, standard deviation=1.11E-05

4. PROPOSED SYSTEM

The system consists of an EMP device which is capable of demolishing any electronic devices when placed near the zone. The device can be made to operate using two modes. One is the manual mode. The manual mode of operation is utilized in places where problems may occur unexpectedly in places like military bomb diffusion, banking sectors etc. Based on that situation the particular user can operate the EMP device through RF module, here the RF receiver module will fixed on the EMP device & the user can trigger the EMP device with the help of RF transmitter. Another mode of operation is the automatic mode. Here the device is employed in places like examination halls, trial rooms etc. By utilizing these modes of operation we can eliminate the misuse of technological advancement. Any gadgets placed near the device working in any of these modes of operation, then the devices can be demolished. The system mode is turned into automatic mode of operation with the help of

WSN module. The user transmits the control signal with the help of WSN from their side. Based on that signal, the automatic mode is operated. The battery used as a source for the working of the EMP device. So we continuously monitor the voltage level sensor values of the battery, to charge it when it runs low on battery.

4.1 Sensitive Terminal Pair

From the experimental results, the sensitive terminal is Emitter-Base junction and output-ground or input-ground for each transistor and integrated circuits respectively. This result is related to the structure of these devices for the reason that EB is usually manufactured with smaller size than others in order to obtain high density of carrier which makes it most vulnerable under pulse voltage.

4.2 Failure Mode and Mechanism

Failure modes of these devices turns to be short circuit with a concurrent sharp decrease in voltage and a sharp increase in current can be easily observed. Energy injected to electronic devices is considered to be responsible for the failure under pulse voltage with the width above 0.1 microseconds.

4.3 Failure energy and the distribution

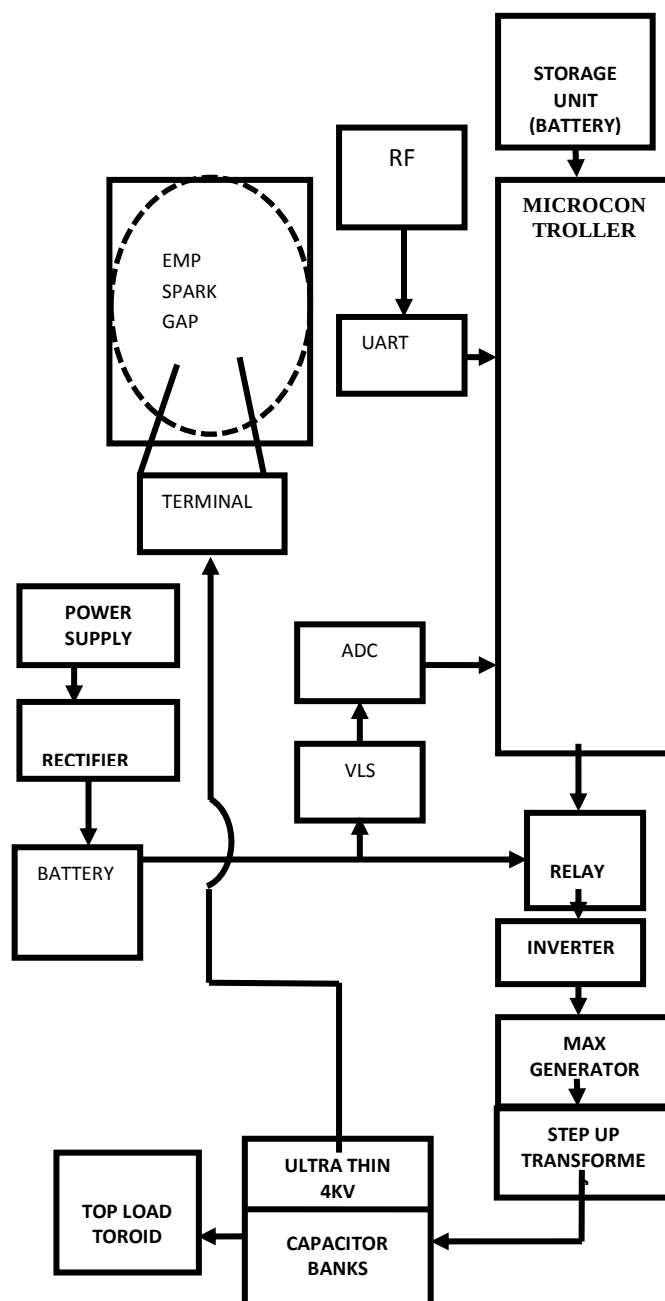
According to the data derived from the experiments, failure energy of different device type or different device pattern in the same type under different pulse type differs greatly with the maximum discrepancy of three orders of magnitude. Smith and Brain proposed a method for data fit with normal, log normal, Weibull, and exponential distribution, but no one type of distribution provide a perfect fit to the data. Jenkins-Durgin model gives the log normal fit based on category data which gives a better fit of data distribution.

5. RF Transmitter and Receiver

5.1 ENCODER

The HT-640 IC encodes 12-bits of information and serially transmits this data on receipt of a Transmit Enable and a LOW

signal on pin-14 /TE. Pin-17 the D_OUT pin of the HT-640 serially transmits whatever data is available on pins 10, 11, 12 and 13, or D0, D1, D2 and D3 to D7.



5.2 RF TRANSMITTER

The TWS-434 transmitter accepts both linear and digital inputs can operate from 1.5 to 12 Volts-DC, and makes building a miniature hand-held RF transmitter very easy. The P2_0, P2_1, P2_2 and P2_3 pin of controller is assumed as data transmit pins. The DATA_OUT pin

of encoder is connected to the DATA_IN pin of RF Transmitter and then the RF Transmitter transmits the data to the receiver.

5.3 RF RECEIVER

The receiver also operates at 433.92MHz, and has a sensitivity of 3uV. The TWS-434 receiver operates from 4.5 to 5.5 volts-DC, and has both linear and digital outputs. The P2_0, P2_1, P2_2 and P2_3 pin of controller is assumed as data transmit pins. The DATA_OUT pin of RF Transmitter is connected to the DATA_IN pin of DECODER and then the data is processed by the decoder.

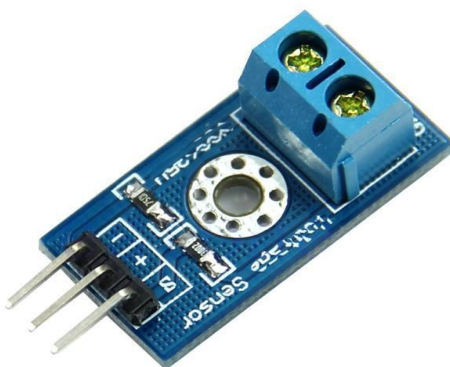
RECEIVER MODULE



TRANSMITTER MODULE



VOLTAGE SENSOR



6. CONCLUSION:

This article studies the failure of 3 varieties six models of electronic devices below 2 styles of magnetism pulse using step stress technique. Waveforms below every voltage area unit documented, still because the failure voltage the time to failure, failure power and failure energy threshold is calculated from the undulation once failure happens. Failure modes is generally short circuit and sensitive terminal combine for the semiconductor is Emitter-Base and input or output to ground terminal combine for integrated circuits severally. within the lightweight of thermal mechanism, failure energy is analyzed, completely different model and types of devices below completely different pulse differs greatly with the maximum optical phenomenon of 3 orders of magnitude. Moreover, the energy threshold offers an honest fit distribution. Failure power of the devices below sq. pulse versus pulse width exhibits a linea dependence once plotting on a log-log scale indicating a power-time relationship of the shape $P=AtB$, and constant B varies with completely different device model, not following the thermally $t^{-1/2}$ time dependence relationship. This article provides a technique to review the failure of electronic devices below magnetism pulse. and also the knowledge derived is helpful for the prediction of untested device sort. This study is effective for the EMP assessment, life time prediction and final hardening of the electronic system. It is of nice significance to review the failure mechanism and establish the information of the failure below completely different electromagnetic pulse for the large and complex electronic device family.

7. REFERENCES:

- [1]] D. Borits, J. Biela, and J. Kolar, "Optimal design of a two-winding inductor bouncer circuit," *IEEE Trans. Plasma Sci.*, vol. 38, no. 10, pp. 2716–2724, Oct. 2010.
- [2] S. H. Ahn, H. J. Ryoo, J.W. Gong, and S. R. Jang, "Low-ripple and highprecision high-voltage DC power supply for pulsed power applications," *IEEE Trans. Plasma Sci.*, vol. 42, no. 10, pp. 3023–3033, Oct. 2014.
- [3] J. Clementson, K. Rahbarnia, O. Grulke, and T. Klinger, "Design of A, B, and C pulse forming networks using the VINPFN application," *IEEE Trans. Power Electron.*, vol. 29, no. 11, pp. 5673–5679, Nov. 2014.
- [4] Dinesh Kumar ,Neelam Rup Prakash and Sukhwinder Singh, Electromagnetic Interference and Compatibility IEEE Transaction nuclear science, 05 October 2017.
- [5] Yasushi Minamitani, Yuya Takeda Sunao Katsuki, Hidenori Akiyama, : Power Modulator and High Voltage Conference (IPMHVC), 2016 IEEE Transaction.
- [6]] T. Shao *et al.*, "A cascaded microsecond-pulse generator for discharge applications," *IEEE Trans. Plasma Sci.*, vol. 42, no. 6, pp. 1721–1728, Jun. 2014.