# FPGA IMPLEMENTATION OF ELECTRONIC WARFARE THREAT SIMULATOR

Dr.R.Murali Prasad
Professor, Department of ECE
Vardhaman College of Engineering
Hyderabad, India

Mr.J.Pandu
Associate Professor, Department of ECE
Sreyas Institute of Engineering &Technology
Hyderabad, India

## ABSTRACT

**In the electronic intelligence (ELINT), Radar is the most significant electronic system used. In warfare and Business airports. This is the source for aircraft detection from the base station. Radar not only detects the native planes but also detects the enemy planes as well. In order to escape from being detected by the enemy radar systems, any country generally employs a technique called as Jamming. In jamming, the aircraft itself detects the electromagnetic waves approaching from the enemy radar, observes the parameters of the signals and transmits electromagnetic waves of a higher frequency thus creating a false impression about the planes position. This work is done by ESM.. The ESM system detects the number of radars, their individual operating frequencies, pulse widths and pulse reflecting intervals (PRI). It can identify all the radars within its operating range. This is done on field level where numbers of radars are actually present. But at the laboratory level, it is very difficult to lay so many radars.. In our project, we provide a pseudo radar environment to the ESM system. Using the simulator, we generate signals which are similar to that of radar signals and pass them on to the ESM which tests these signals like it does in the field.**

**Keywords:** ESM, Electronic Warfare, Simulator, Stagger, PRI, Jitter.

## I. INTRODUCTION

In real time, as we have a tendency to aware, there are varies of radars that are employed to detect the flying air bodies and detect their speed, type, degree of destruction it can cause and so on. But when an Aircraft has to avoid itself from being detected by any Radar in order from being detected, it must employ some technique to escape from the detecting Radars. This technique is called as Jamming.

In this Jamming technique, a machine called the electronic support measures (ESM) is placed within the aircraft which works all the time once the aircraft enters the enemy borders. This ESM machine, has a module called as the BITE controller which absorbs each and every Radar signal which is hitting the plane. It then calculates all the parameters such as Frequency, and Pulse width. This concludes what kind of Radar it is. Once these parameters are calculated, we can avoid ourselves from being detected by that Radar. But to practically test the ESM system by employing so many numbers in a testing area is not easily possible. In order to overcome this difficulty, we are generating different signals and these signals are fed to the ESM system which resemble the various signals generated by several number of Radars placed in the real time battle field.

These test signals may be of continuous, stagger or jitter form. Our role is to generate these different types of signals, test their parameters accurately and run them to check for the outputs. For this purpose, we are using different software tools and also several hardware blocks whose functioning and detail explanation is provided in the subsequent chapters .This is a very useful for the Indian Defense Forces because, if they can successfully implement this concept in their aircrafts, they can be avoided from being detected by the enemy Radars and our targets can be achieved. We can also overcome the loss of property and lives during wartime.

## II. ELECTRONIC SUPPORT MEASURES

The primary objective of an ESM system is to intercept the enemy electronic systems in a tactical, real-time environment. Interception of hostile electronic environment is generally attempted to achieve three basic functions-detection, frequency estimation and direction finding. These three elements of interception are usually integrated in a practical system Design. Detection is achieved by using radiometer, channelized radiometer or the cross correlate Frequency estimation is achieved by using ESM receivers. Direction-finding is achieved by using special DF antennas, which provide measure of angle of arrival (AOA) of emitter pulses.

The basic principal of an ESM receiver is to provide information on the existence and nature of various signals usually in the minimum possible time. An ESM system is used to detect the following whether any signals are present or not .The electrical characteristics and directional bearing to those signals present CW signals and FM signals. Single sideband suppressed (SSB) signals are present that shows the characteristics of motion of a target.

Tracking the location of the intercept receiver. However, the aim of an ESM system remains the same, i.e., to provide a source of information for immediate reaction involving ECM, ECCM, avoidance, and targeting. There are two basic types of ESM one is Electronic Intelligence (ELINT) Communications Intelligence (COMINT).

## III. ELECTRONIC INTELLIGENCE (ELINT)

The primary objective of an ELINT system is to compile operational data on enemy electronic systems and weapons. ELINT is usually carried out on a regular basis, both during times of peace and war, as well as just prior to and during specific missions. The latter ELINT effort is made in order to evaluate the enemy defensive weapons, early warning radars, ECM and ECCM are used to determine the manner in which to conduct the mission. Specially equipped ships, aircraft, RPVs, satellites, as well as fixed and mobile land-based facilities are used for collection of ELINT.

In general, ELINT serves a strategic role of the enemy, as well as a tactical role in helping to develop or reprogram appropriate ECM and ECCM equipment to meet each threat. The basic targets of ELINT are all types of radars, which are detected, located and identified by their signatures in their operating modes (e.g. search, tracking).Special ELINT systems have been developed which scan each frequency band continuously, perform a real-time analysis of each intercepted signal, determine its signature and compare this with others in a library in order to identify and locate the threat.

ELINT is also used to obtain data on enemy navigational systems, command, data and telemetry an links, the control and guidance techniques used for each weapon system ( RF, IR. TV or laser) and the ECCM employed .Thus ELINT operations satisfy a variety of requirements .They can locate hostile electronic systems and weapons, update hostile force electronic order of battle (EOB) information, obtain information on specific transmitters and emissions, test hostile force ECM capabilities.

## IV. ELECTRONIC WARFARE

Electronic warfare (EW) is any action involving the use of the electromagnetic spectrum or directed energy to control the spectrum, attack an enemy, or impede enemy assaults via the spectrum. The purpose of electronic warfare is to deny the opponent the advantage of, and ensure friendly unimpeded access to, the EM spectrum. EW can be applied from air, sea, land, and space by manned and unmanned systems, and can target humans, communications, radar, or other assets. Military operations are executed in an information environment increasingly complicated by the electromagnetic (EM) spectrum.

In The electromagnetic spectrum portion of the information environment is referred to as the electromagnetic environment (EME). The recognized need for military forces to have unimpeded access and use of the electromagnetic environment creates vulnerabilities and opportunities for electronic warfare (EW) in support of military operations within the information operations construct. EW is an element of information in the warfare more specifically; it is an element of offensive and defensive counter information.

## V. THREAT SIMULATOR

The Radar Threat Simulator (RTS) is a smart simulation test and evaluation system used to generate realistic threat radar waveforms. The RTS has several configurations and has been used in a variety of applications including laboratory-based modeling and simulation, threat emulation, high-powered ground-based anti-aircraft threat emitters, and an airborne pod configuration for simulating anti-ship cruise missiles.

The RTS provides realistic training for shipboard electronic warfare (EW) personnel and systems. The RTS provides realistic missile seeker emissions to evaluate the operation of RF decoys and other EW systems; and provides a cost-effective in-house test, training, and validation capability. The main aim of the Threat simulator is to generate different kinds of signals such as Stable PRI signal, Staggered PRI signal and Jittered signal.

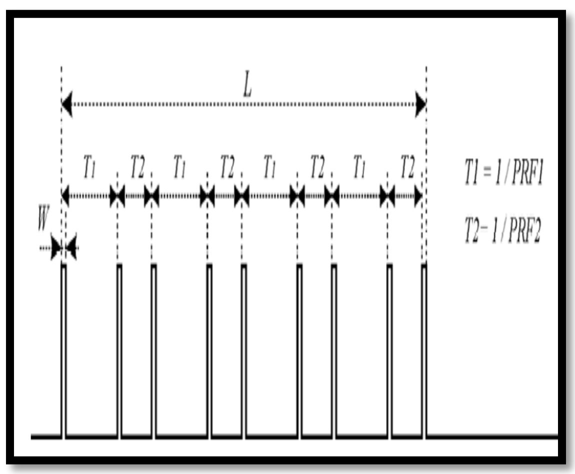



**Figure1. Staggered PRI signal**

The ESM systems employed in the Aircrafts are used to detect the RADARs in the enemy country during war or peace time. But it is not practically possible to test the ESM machine employing so many different types of RADARs in the laboratory. To overcome this limitation, we are designing and programming a system which produces outputs similar to the outputs of the RADARs. Thus the ESM system can be tested. The PRIs up-to 2000 levels can be generated. This paper is developed to the generation of inter-pulse modulations of EW threat simulation.

Inter pulse modulations helps in simulation of following radars Long PRI (low PRF) - Long range radars, Short PRI – Pulse Doppler radar Very Stable PRI – MTI Radar. Resolve range and velocity ambiguities, eliminate blind speed in MTI, minimizing search times, and defeat certain types ECM jamming This paper focuses on implementation of inter pulse modulations on FPGA. Code is developed in Verilog and synthesized using Quartus II tools. Timing analysis of each and every block is explained by Modalism. And the code is dumped on to the FPGA using RS232 link or a LAN link .The block diagram of the Signal generator is shown below.

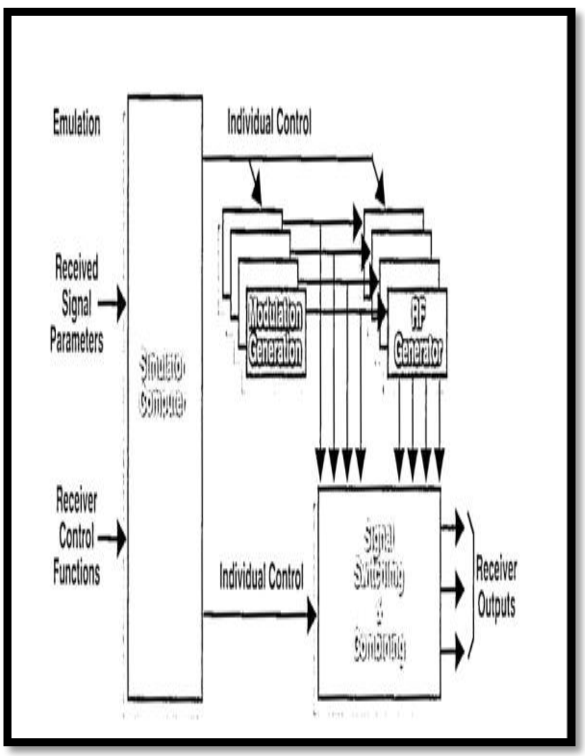
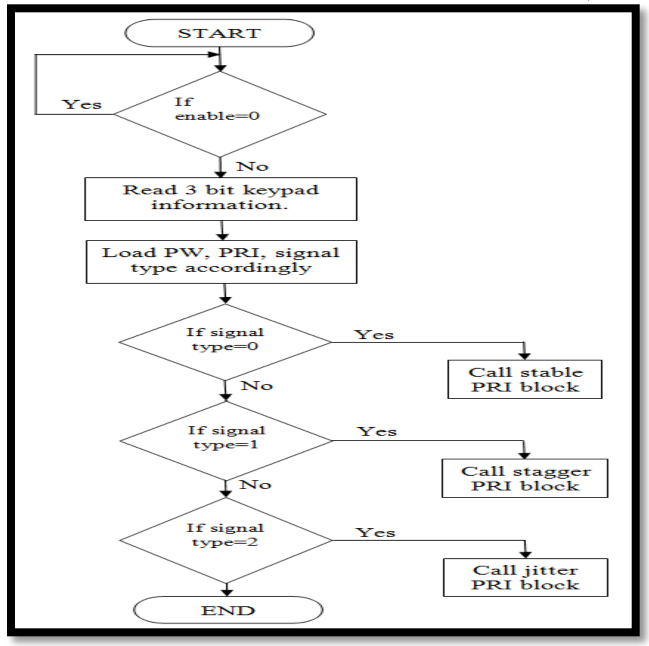



**Figure 2 .Signal Generator Block diagram**

The different blocks employed in the block diagram are listed below and their description is given in detail. Simulation computer, Modulation generator, RF generator RF combiner .The main role of the computer is the conversion of time to pulse counts and calculating the PRI levels.




This flow chart shows how the signals have been generated using the appropriate signals given by the user. In the process of testing and dumping of the code on the FPGA board would not be possible without the use of few software tools used in our paper. Updated software tools were used to compile and execute the codes. The tools which were used are modalism, Quartus II, Cyclone IV FPGA. Once the code is written, it is tested on modalism after testing. The waveforms and the timing signals are verify, they are put into Quartus tool. The modalism code is converted into separate code for individual blocks. This code is dumped into FPGA board. The FPGA is connected to CRO for checking the output signals.

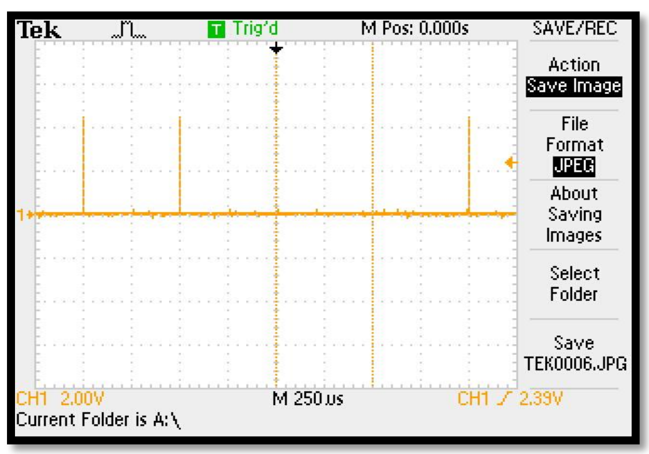



**Figure 3. Staggered PRI signal**

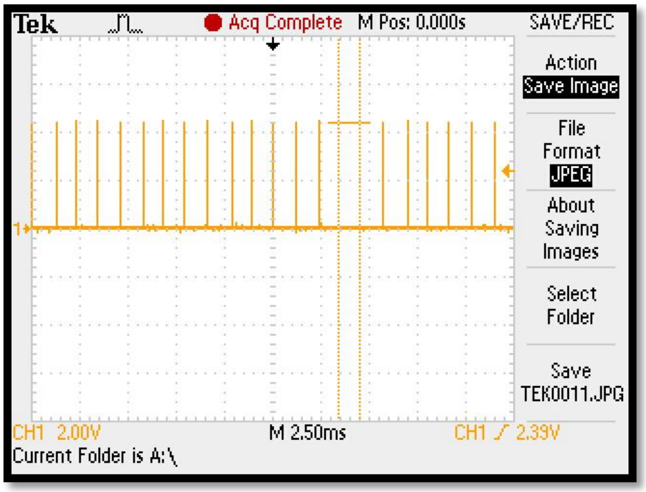



**Figure 4. Jitter PRI signal**

# VI. CONCLUSION AND FUTURE SCOPE

The code written for Stagger and Jitter gives the output in pulses form which consists of pulse width and pulse repetition interval for stable stagger level and for jitter percentage. The waveforms can be measured in Cathode-ray oscilloscope. This circuit of FPGA based Stagger and Jitter PRI generator is helpful and low-cost compared to any standard pulse generator. This circuit uses FPGA, as pulse generator will vary PRF attributes to check the functionality of ESM/ECM sub-system in lab itself. This circuit is very much useful in checking of EW systems.

This concept can be used for many Applications like air-traffic control and also during times of war. This FPGA based circuit can be programmed to generate general purpose pulse generator output. This can be used in a lab as a mini pulse generator. There is a scope to improve all the designs using latest versions of FPGA with that achieve the minimization of Hardware, increase of speed, high performance and high capacity. With the use of upgraded versions, can reduce the hardware as well as manufacturing cost and achieve large designs in a compact model. In the future, the Radar Scope could be extended to sensor arrays that yield 3D imagery of a room.

Taking this further, future developments promise to image through multiple walls and even penetrate whole buildings using distributed sensors on or around buildings, carried by Soldiers, vehicles, even UAVs. This EW threat simulator is used in Radio Frequency (RF) generation and in detection of Antenna radiation pattern .It can also be used in Intra pulse modulation as an extension of this paper.

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## BIOGRAPHY

**Prof. R. Murali prasad** obtained his B. Tech degree from Institute of Engineers (IE) Calcutta. He received Master's degree from Pondicherry Engineering College and Received his Ph.D from Jawaharlal Nehru Technological University, Anantapur. Presently he is working as a Professor in the Department of

ECE, Vardhaman College of Engineering Shamshabad Hyderabad, He is a life Member of ISTE . His areas of research interest are Signal Processing and Communication Systems.

**Mr. J. Pandu** obtained is B.Tech degree from VNR Vignana Jyothi Institute of Technology, Bachupally, Hyderabad. He recived Master's degree from Osmania University Hyderabad and Pursuing his (Ph.D) from JNTUH Hyderabad. Presently he is working as a Assoc professor and HOD in the Department of ECE, Sreyas Institute of Engineering &Technology, Nagole, Hyderabad. He is a life Member of ISTE . His areas of research interest are Signal Processing, Radar, and Embedded Systems