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Development of Receiver Interfacing Board for Microwave and Digital Receiver

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ABSTRACT:

Today, almost everybody is familiar with fighter aircraft, battle tanks, warships and submarines. A majority of people have seen them in action, either directly or via television or films. But there is another kind of invisible fight involving the use of radio and radar emissions which is always going on in the atmosphere. i.e; In the Electronic Warfare (EW) Receiver receive signals from free space. Electronic Warfare is the military use of electronics to prevent or reduce an enemy's effective use and to protect friendly use of electromagnetic radiation equipment. This project is implemented to capture the signals in free space, using RDF receiver even signal was captured at low power. The Signals received by Omni antenna and Rotary Direction Finding antenna, those connected to Dual Channelizer Receiver which converts 18-40 GHz RF signal to either 1GHz or 160MHz IF signal based on the tuning commands given by the user. Here, to tuning and receiving of particular Ku and K band frequency signal continuously varying and which was monitored by the end user. To interface with the system it requires a media called RIB Receiver interface board to send commands to Channelizer and Digital Receiver. The IF signal is processed by Digital Receiver to measure signal parameters. Receiver Interface Board is used to generate commands for Dual Channelizer Receiver and Digital Receiver. Finally the system will able calculate signal parameters like Pulse Width, Pulse Period and Frequency and DOA. Here to interface RIB Board Vertex-5 was used.

Keywords: ***Rotary Direction Finding Antenna, Omni antenna, Dual Channelizer receiver, Receiver interface Board, DOA-Direction of Arrival.***

INTRODUCTION

Military electronic systems are usually designed to perform such functions as general surveillance, identification, fire control, communications, and jamming. All such functions involve the transmission and/or reception of signals by electromagnetic propagation. Although in general these functions require subsystems with considerable overlap (such as antennas, transmitters, receivers, signal processors, and data processors), most military electronic equipment is designed and constructed to perform only limited tasks, and the mission goals are usually met with a collection of separate systems. In some instances, however, two or more systems could be combined to obtain cost-effective performance by sharing expensive components or subsystems. These are stories, perhaps not completely valid, about the sharing of system resources in the past. During World War 11, identification interrogation messages were transmitted and replies were received on the radar. Later, IFF systems became completely separate from radar. There is considerable interest today in placing the challenge portion (not the air-traffic-control function) of the IFF system back into radars. The SAGE (Semiautomatic Ground Environment) system use d long-range surveillance radars to communicate information. The electronic-support-measure (ESM) and radar systems have shared antennas in some surveillance systems and have shared a number of components in

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missile weapon systems. For example, a missile might home on either radar reflections or jamming signals. Radars have often acted as jammers, even if inadvertently, by providing strong interference to other electronic equipment, In some fire-control systems, commands or data are transferred to the missile with the radar. We will explore in this report two major areas: design of a radar-communication system and applications of such a system. We will restrict the discussion of radar-communication design to the use of a scanning surveillance radar. We will look at a number of alternatives and discuss a tentative design to be implemented for demonstration. After we address possible applications of radar communications, we will give plans for a demonstration of an effective use of a radar-communication system.

Military systems worldwide are forever challenged by the growing demands of a digitally enriched experience in the battlefield Arena. The sensor to shooter experience covers a wide gamut of platforms which address diverse and challenging needs such as Speed, Range, Resolution, Band width in the Communications and Non-communications environment across all four dimensions namely Land, Air, Sea and Space. Underlying this experience is the strong need for technology domain expertise which centers around Digital Electronics and Radio Frequency of which the core technology revolves around Digital Signal Processing, Base Band processing, Image and Video processing, Embedded computing, Semiconductor Design and Control interfaces as well as RF as front ends.

BLOCK DIAGRAM

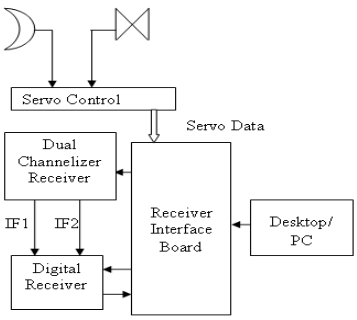

Fig.1: Block Diagram of Development of RIB for Microwave and Digital Receiver.

In the figure there are two antennas named RDF which is used for receiving signal from free space and helps in detecting the RF signals from Ku, K and Ka band where as omni antenna used for suppress the side lobes which are presented in the received the RF Signal.

In general the frequency of EM Spectrum varies from DC to 40 GHz. Here in Ku , K and Ka band deals the frequencies from 18-40 GHz band. So, Here the RDF antenna receives the RF signals from 18GHz to 40 GHz. There after the output of RDF antenna was given to Servo Control to find the DOA of the received signal. The Servo Control which can gives the Servo_Data (12-bit data) to RIB board to send Digital Receiver.

The Dual channelizer Receiver has two inputs one is RDF signal and second one is Omni signal. Here the received input signal strengthen by increasing the gain of the signal by amplifying the signal. The Dual Channelizer was provides 35 dB Gain to the input signal and down converts the input RF signal IF signals. The Dual Channelizer designed to generate IF signals of 1GHz and 160 MHz band width.

The IF output of Channelizer receiver of given to Digital receiver to calculate the signal Parameters like Pulse Period, Pulse Width and frequency and Time of Arrival and Direction of arrival.

But , the total process can be controlled by the end user to scan the signals from outside environment. The enemy radars will transmits the signals towards the targets to destroy and track the objects. To track enemy radar signal our system continuously scan the signals. For that controlling an interface board was designed.

For scan the particular frequency signal RIB has to send the following parameters to the Dual Channelizer.
They are

1. RF/BITE Mode
2. Set Frequency
3. IF Band Width
4. Attenuation

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The command word for controlling and tuning of Dual Channelizer has 18 Bytes.
Ex: 474A 05 0100 01 00 01 00 01 EEEE
The interface block diagram was given in Fig.2. as shown in below.

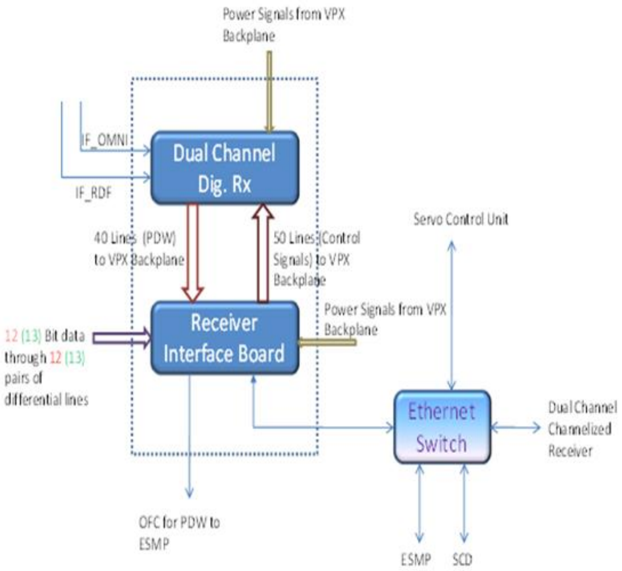

Fig.2: Interface block diagram for RIB board

Here , The RIB Board contains the VERTEX-5 FPGA board. The device inside the FPGA board was XC7VX485T.

Virtex-5 FPGA Logic

- On average, one to two speed grade improvement over Virtex-4 devices
- Cascadable 32-bit variable shift registers or 64-bit distributed memory capability
- Superior routing architecture with enhanced diagonal routing supports block-to-block connectivity with minimal hops
- Up to 330,000 logic cells including:
  Up to 207,360 internal fabric flip-flops with clock enable (XC5VLX330)
  Up to 207,360 real 6-input look-up tables (LUTs) with greater than 13 million total LUT bits
  Two outputs for dual 5-LUT mode gives enhanced utilization
  Logic expanding multiplexers and I/O registers.

To transfer the data to Dual Channelizer over Ethernet a Protocol was used. The best protocol which was used in FPGA Programming is Aurora 8B/10B is used. To interface the with hardware of FPGA devices like Ethernet, Timers, RS-232, and Interrupts Control Xilinx EDK tool was used.

Aurora 8B/10B Protocol:

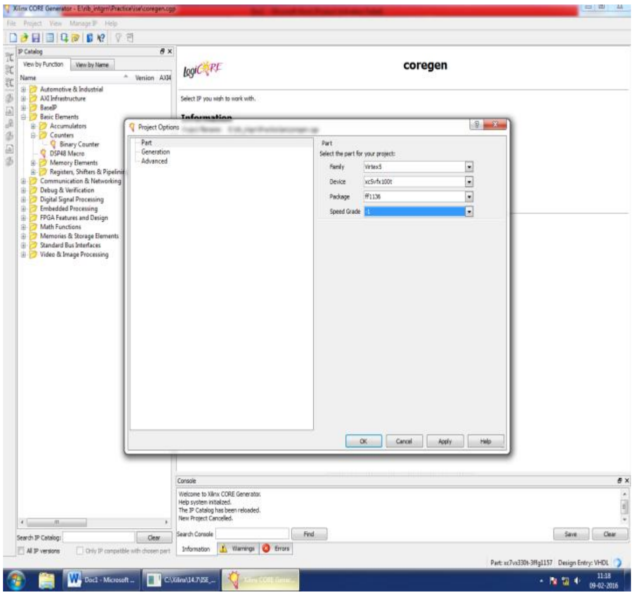

Fig.3: Xilinx Core generator for Aurora 8B/10B

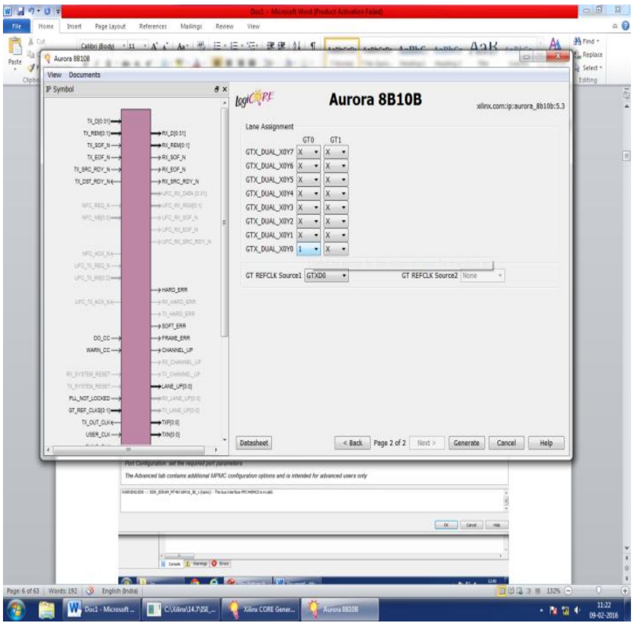

Fig.4: Xilinx Aurora 8B/10B IP Protocol channel selection

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Xilinx Platform Studio (EDK)

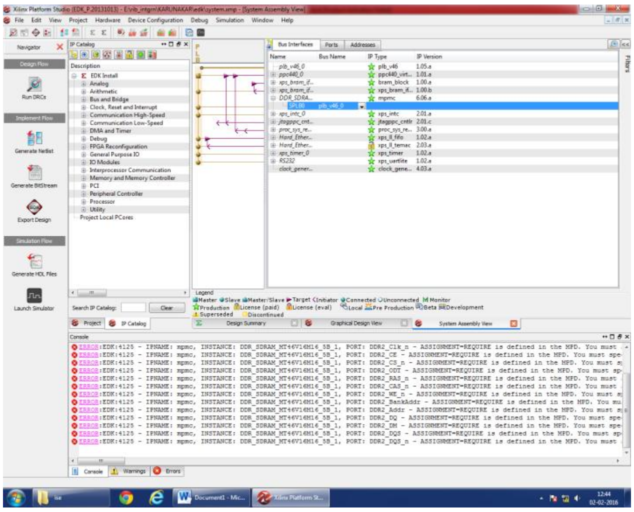

Fig.5: FPGA interface connections using EDK

RESULTS

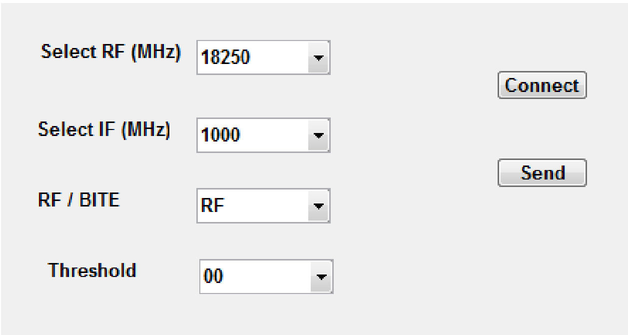

Fig.6: Parameters Required to Process Signal

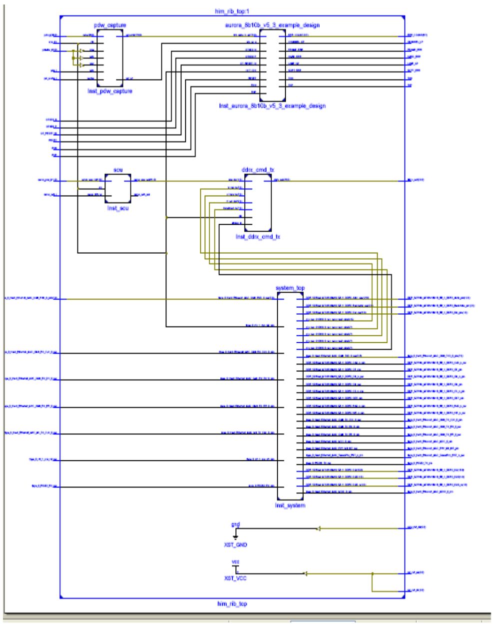

Fig.7: RTL Top Module for RIB interface

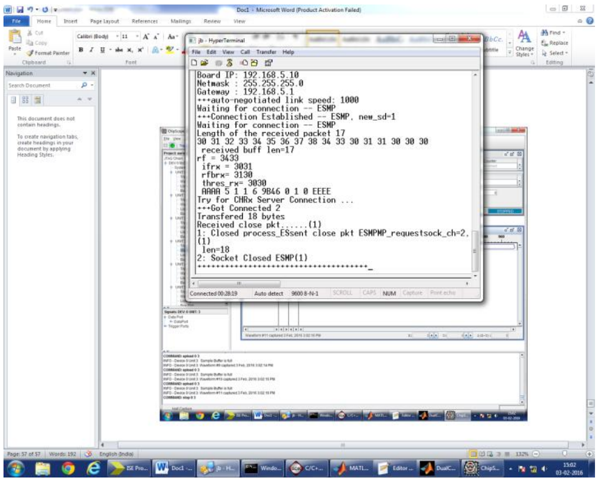

Fig 8: Terminal data output through RS-232 to RIB

CONCLUSION

The EW system was calculated the Received RF signal parameters even if the signal has lower power. The RDF antenna was pick up the signal which was tuned by the user with the help of RIB board Successfully. The data rate to transfer the command to channeliser was achecived 1Gbps with the help of Aurora Protocal. Hence, The RF signal parameters calculated using Digital receiver and output was displayed on SCD.

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