Baseband Signal Generation for Multi-Function Phased Array Radar

M.Shanmuga Priya, M.Uma Saranya, S.Anitha Kumari, S.Tamil Selvi

Abstract: The multi-function phased array radar (MPAR) is used for weather monitoring, air-traffic control requirements and non-cooperative elements monitoring in a parallel manner. The amplitude of the radio frequency signal is varied depending on the location of the target from the radar. The proposed work generates a signal which is used as a input for RF transmitter of Multifunction Phased Array Radar. To achieve this MPAR requirement, the in-phase and quadrature-phase samples are generated for a high data rate using MATLAB and then VHDL output was obtained from Xilinx for QPSK and QAM modulation techniques.

Keywords*: *Multifunction Phased Array Radar (MPAR), QAM, QPSK, MATLAB, VHDL.

I. INTRODUCTION

Multifunction Phased Array Radar is a Doppler radar system. It could scan at an angle of 60 degrees in elevation, and track meteorological phenomena, biological flyers, non-cooperative aircraft, and traffic simultaneously.

The MPAR was derived from a U.S. Navy shipborne radar, the AN/SPY-1. MPAR was installed on the USS Norton Sound in 1973. AN/SPY-1 was the standard air search radar. MPAR is nice for radiolocation and made phased array radars a chief candidate for implementation within the meteorological spectrum. Different versions of the AN/SPY family arose in 2003 through the 1990s.

Conventional radars typically used for focussing the radar beam, and rely upon motors to maneuver the dish in azimuth and elevation. Against this, phased arrays are an antenna array, composed of the various small antennas, which steer the radar beam electronically by changing the phase of the signal emitted from each antenna element. The signals from each element add together within the specified direction and do away with in other directions, a phenomenon said as interference. The requirement for motors and moving

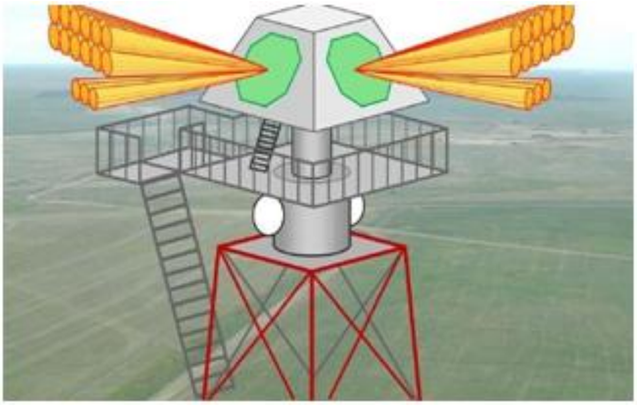

Fig. 1.MPAR Concept.

parts are obviated by this capability, which decreases the worth of the system and increases the reliability [1]. The aim of the proposed design is to come back up with a baseband signal with the following rate for MPAR. For this, the basic modulation techniques QPSK and QAM are used.

II. REVIEW CRITERIA

The MPAR working party established three focus issues for special attention: affordability, multi-functionality, and dual polarization. A phased array radar contains a flat panel of the unique antenna. The panel is created of a grid of fixed antenna elements, and every panel can transmit and receive a sign. Radar scans will make severe weather easier to verify, making warnings more accurate and reducing false alarms every minute [2].

The command and control operation is employed to partitioning the scan time among these missions and therefore the techniques for increasing scan rate where feasible were utilized. The airport and national aircraft surveillance indicate that 40–60% of the MPAR scan timeline would be available for the high - fidelity weather observations. Overlapping coverage of systems will enhance surveillance quality. Consolidation of operational systems would likely reduce acquisition and life - cycle costs through economies of scale and through streamlining of maintenance, logistics, and second-level engineering service organizations. a very important aspect of the C2 approach described herein is that pulse transmissions on the various faces of the radar would be synchronous, attributable to the quasi-deterministic schedule for the aircraft and weather volume scans [3].

The look includes multiple features that enable high isolation between ports, reduction of spurious radiation, highly symmetrical radiated fields, and suppression of diffracted fields between contiguous sub-array gaps.

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For radar, simulated and measured results, including electronic scanning of the array and embedded element patterns of the antenna to verify the polarimetric requirements. A stacked patch configuration was adopted to beat the bandwidth difficulty. The utilization of multiple techniques for improving the performance of an antenna element that might satisfy today's requirements for phased array weather radars was presented. A brand new coupling mechanism, the cross-patch ratio, was discussed and results show how this parameter could help to realize the desired coupling on an aperture coupled patch antenna [4].

A multifunction airborne radar device consists of a plurality of transmitter antenna modules and/or receiver antenna modules that are fixed relative to the aircraft. The antenna modules are placed over the surface of the aircraft to form transmit and receive beams. The airborne radar device is additionally comprised of processing which suggests tracking the detected targets and for generating information sent to a traffic center and/or to a bearing device onboard the aircraft. Radar systems fitted in aircraft comprise a minimum of 1 mechanically rotated or electronic scanning antenna. It makes it possible to induce a tool, which forms the subject matter hereof, with wide angular coverage in standby mode, with a high rate, without impairing the performance of the target tracking function [5].

III. MODULATION TECHNIQUES

A. Qpsk Modulation:

QPSK also called bigots because it sends two bits of digital information at a time. The QPSK Modulator uses a bit-splitter, a 2-bit serial to parallel converter, two multipliers with a part oscillator, and a summer circuit. The even bits (i.e., 2nd bit, 4th bit, 6th bit, etc.) and odd bits (i.e., 1st bit, 3rd bit, 5th bit, etc.) of the message signal are separated by the bit splitter at the modulator's input and are multiplied with the identical carrier to come back up with odd BPSK (called as PSKI) and even BPSK (called as PSKQ). Before modulation, the PSKQ signal is phase-shifted by 90° [6].

$$s(t)=A\cos[2\pi f_c t+\theta_n],\ 0\le t\le T_{sym},\quad n=1,2,3,4$$

B. Qam Modulation:

QAM can provide a highly effective form of modulation for data and in and of itself it's employed in everything from cellular phones to Wi-Fi and almost every other form of the high-speed data communications system. Quadrature AM, QAM, when used for digital transmission for radio communications applications can carry higher data rates than ordinary amplitude-modulated schemes and phase-modulated schemes. Basic signals exhibit only two positions which enable the transfer of message either a 0 or 1.

Using QAM many alternative points are often used, each having defined values of phase and amplitude. This could be stated as a constellation diagram. The assorted positions are assigned different values, and through this fashion, one signal can transfer data at a far higher rate [7].

$$r(t)=s(t)=v_I(t)\sqrt{2}\cos 2\pi f_c t-v_Q(t)\sqrt{2}\cos 2\pi f_c t$$

IV.RESULTS AND DISCUSSION

The QPSK and QAM modulation has been studied. The random input bits are generated for QPSK and 16-QAM. The signals were converted into Non-return to zero formats (Therefore the analog signals were converted into digital signals).To transmit more bits at one time, Serial to Parallel converter was used. Due to the usage of Serial to parallel converter the transmitting speed was increased. After that, in-phase and quadrature-phase signals are separated by using the Phase shifter. Then the QPSK modulation output has been obtained by combining the in-phase signal and quadrature-phase signal.

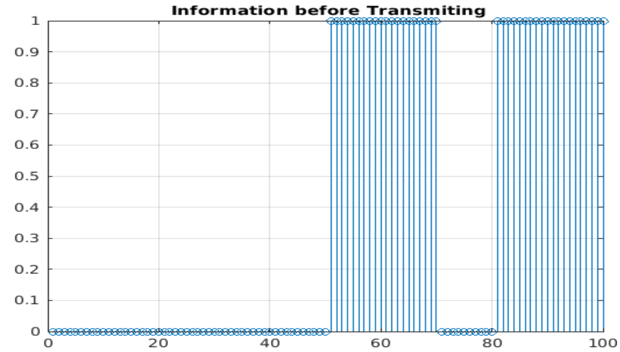

Fig. 2.The Input of QPSK Modulation.

As shown in Fig.2, the input information for the QPSK modulation before transmitting was generated. The x-axis refers to the time and Y-axis refers to the amplitude that's randomly generated signal.

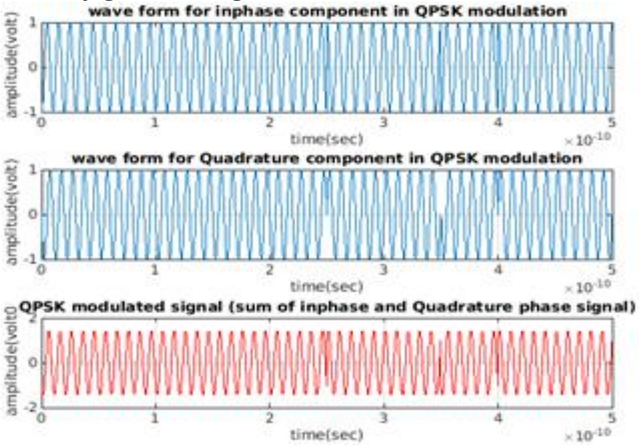

Fig. 3.The output of QPSK Modulation.

As shown in Fig.3, the output waveform for the QPSK modulation was generated. The x-axis refers to the time and Y-axis refers to the amplitude. The1st and 2nd waveforms were in-phase signals and quadrature-phase signal and also the third waveform was a sum of those signals.

Fig. 4.The input of QPSK Modulation after Receiving.

As shown in Fig.4, the input information for the QPSK modulation after receiving was obtained. The x-axis refers to the time and Y-axis refers to the amplitude.

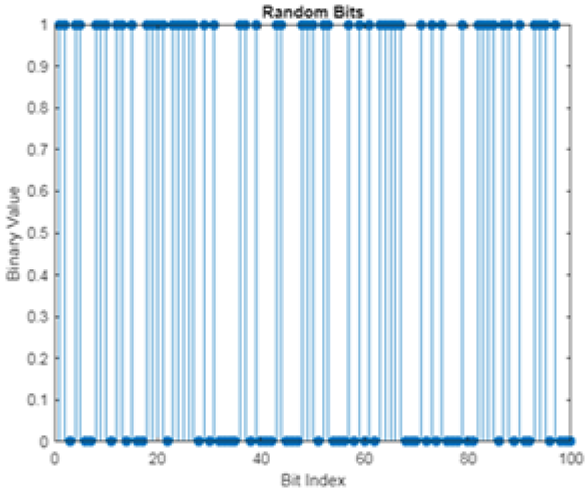

Fig. 5.Random Input bits of 16-QAM.

As shown in Fig.5, the random bits for the 16-QAM modulation were generated. These bits got as input to the 16-QAM modulation. The x-axis refers to the bit index and Y-axis refers to the binary value.

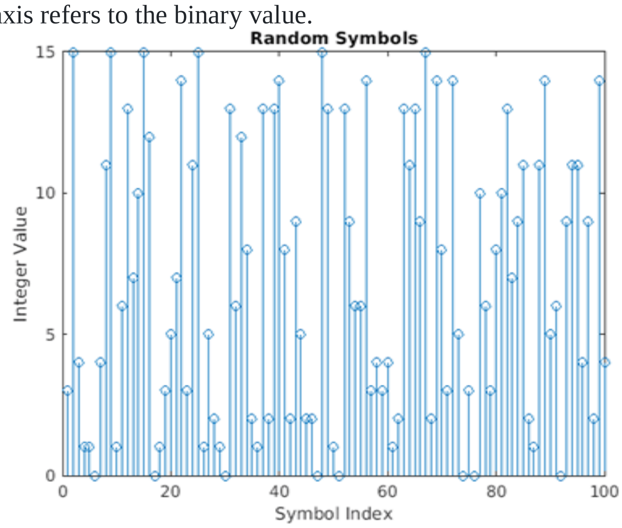

Fig. 6.Input symbol of 16-QAM.

As shown in Fig.6, the random symbols for the 16-QAM were generated. These symbols got to the 16-QAM. The x-axis refers to the symbol index and Y-axis refers to the Integer value.

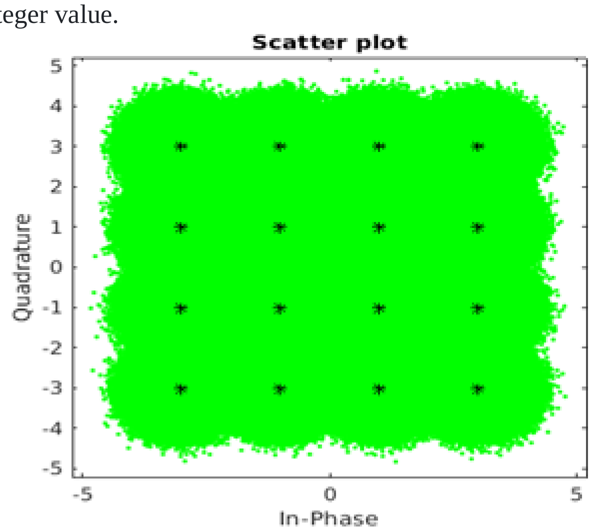

Fig. 7.Constellation of 16-QAM.

As shown in Fig.7, the output Constellation diagram for 16-QAM was obtained. The x-axis refers to the In-phase signals and Y-axis refers to the Quadrature-phase signals. QAM produces accurate results and efficiency for transmission. By comparing QPSK and 16-QAM, 16-QAM is best for utilizing both amplitude and phase variations at the identical time and more points occupied in a very constellation.

The VHDL output was obtained from Xilinx (ISE) 8.2i software version.

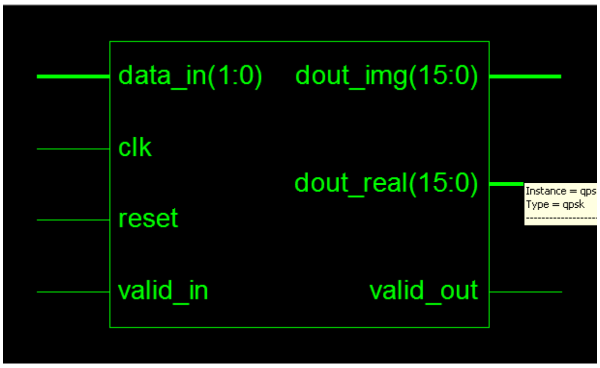

Fig. 8.Pin Diagram of QPSK.

As shown in Fig.8, the diagram of QPSK was obtained from the VHDL code. This diagram consists of input and output which got within the ports of the VHDL code.

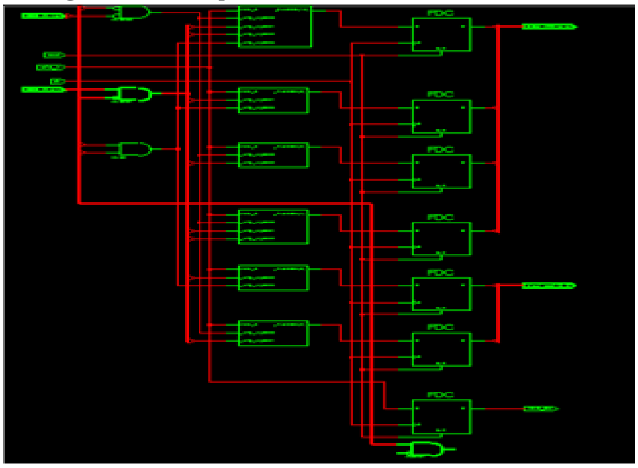

Fig. 9.Schematic Diagram of QPSK.

As shown in fig.9, a schematic diagram of QPSK was obtained from the diagram of QPSK. This diagram contains FDC, mux, OR and AND gates.

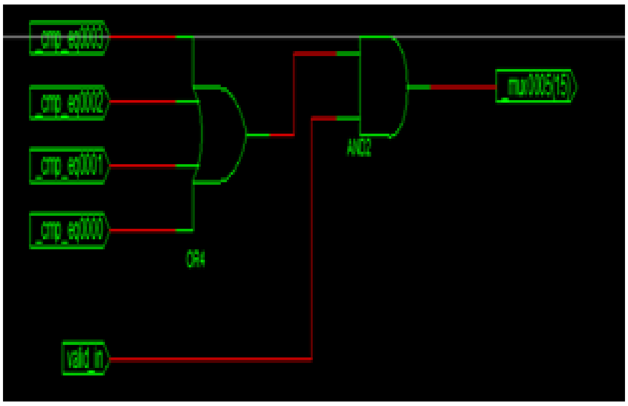

Fig. 10. Internal Structure of QPSK.

As shown in Fig.10, the interior structure of QPSK provides the output of mux. It contains OR and ANDgates.

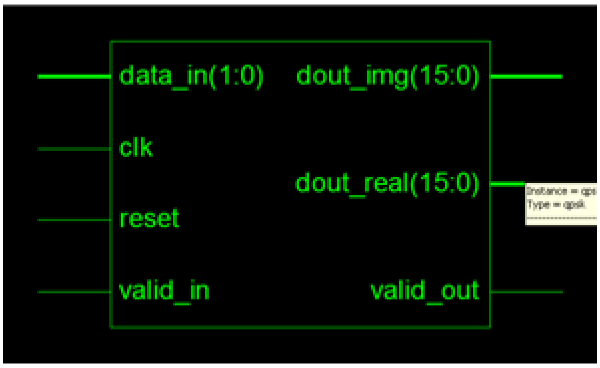

Fig. 11. Pin Diagram of 16-QAM.

As shown in Fig.11, the diagram of 16-QAM was generated from the VHDL code. This diagram consists of input and output which got within the ports of the VHDL code.

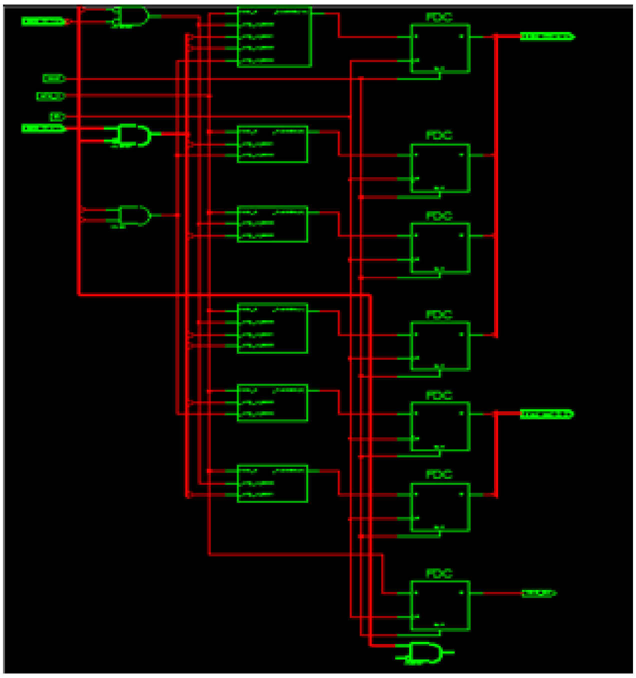

Fig. 12. Schematic Diagram of 16-QAM.

As shown in Fig.12, the schematic diagram of 16-QAM was obtained from the diagram of QAM. This diagram contains FDC, mux, OR and AND gates.

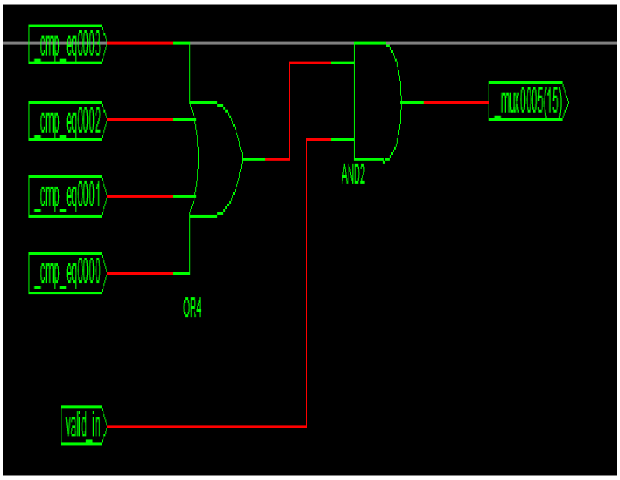

Fig. 13. Internal Structure of 16-QAM.

As shown in Fig.13, the internal structure of 16-QAM was generated with OR and AND gates.

V. CONCLUSION

For MPAR, the baseband signal was generated at a 10Gbps data rate using MATLAB and modulations QPSK and 16-QAM was simulated with VHDL code .This high data rate signal is required for the effective function of RF transmitter in a Multi-function Phased Array Radar.

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