

## Review on Power Amplifier for WSN Applications

Prof. Vaibhav S. Girnale<sup>1</sup>, Prof. Harshavardhan B. Patil<sup>2</sup>

<sup>1</sup> Department of Electronics and Telecommunication Engineering, STC, SERT, Shegaon, Maharashtra, India

<sup>2</sup> Department of Electronics and Telecommunication Engineering, STC, SERT, Shegaon, Maharashtra, India

\*\*\*

**Abstract** - Power amplifier is one of the important parts of transceiver. The main important parameter for power amplifier is output power and power added efficiency (PAE). There are various technologies used for power amplifiers designing such as CMOS, p HEMT GaAs, GaAs-HBT, BiCMOS technology. For analysis of power amplifier Power Added Efficiency (PAE) is important factor. Drain efficiency and Power Added Efficiency are two types of efficiencies of power amplifier. Power amplifier is used in various wireless sensor network applications. Two stage topology is implementing for obtaining high gain, efficiency of power amplifier. This paper gives the study of various power amplifiers which helps to achieve multi-standards in wireless communication system. Advance Design System software (ADS) is use for designing of power amplifier.

of the main part of wireless sensor network (WSN) nodes. CMOS power amplifier also works at lower frequency than GaAs power amplifier. CMOS power amplifier shows more linearity than GaAs and GaN technology. Power dissipation is less in CMOS technology as compare to GaAs technology.

For calculation of input output return losses, gain of power amplifier scattering parameter analysis is carried out. There are four main s-parameters for designing of a power amplifier. It includes input return loss  $S(1,1)$ , output return loss  $S(2,2)$ , gain  $S(2,1)$  and isolation loss  $S(1,2)$ . In this paper different work done on designs of power amplifiers are discussed.

This paper is organized as follows- Section II covers the related work done for power amplifier. Section III covers the proposed methodology for designing of power amplifier and Section IV cover the conclusion and Future work for power amplifier.

**Key Words:** Power amplifier, Advance Design System software (ADS), WSN, operating frequency, VLSI

### 1. INTRODUCTION

Power amplifier is one of the main parts of transceiver. In wireless sensor network power amplifier is used. The main function of power amplifier is to amplify input signals. Output power and power added efficiency (PAE) are the main performance parameter of power amplifier. Power amplifier consumes more power as compared with parts of transceiver. There are different technologies are use for designing of power amplifier such as CMOS, GaAs p HEMT (pseudomorphic High Electron Mobility Transistor), HBT(Hetero Junction Bipolar Transistor), GaN(Gallium Nitrite) technology. TriQuint GaAs pseudomorphic high electron mobility transistor (P HEMT) technology is used for designing of two stage power amplifier. GaAs technology has higher speed of operation as compared to CMOS technology. GaAs technology provides high output power and efficiency than CMOS technology. Development in high electron mobility transistors is called as pseudomorphic high electron mobility transistors (pHEMT). pseudomorphic high electron mobility transistors are widely used in power amplifier, low noise amplifier, wireless communications. The GaAs device technology is used in high frequency range as compared to other technology. Wireless sensor network is one of the special types of network made up of numbers of nodes. The size of all these nodes is different. Transceiver circuit is one

### 2. RELATED WORK

Two stage (MMIC) medium power amplifier for 5.8 GHz applications using a 0.5 $\mu$ m commercial GaAs pseudomorphic high electron mobility transistor (PHEMT) technology presented by Amiza Rasmi, A. Marzuki, M. Azmi Ismai[1]. This medium power amplifier shows for 5.8 GHz having gain of 16.39dB, and the power added efficiency (PAE) is 25.30% and 1dB output power is 20.18dBm. Stability factor of medium power amplifier (MPA) is 13.60. This medium power amplifier has total current of 200.2mA. The chip size of medium power amplifier is 1.7 x 0.85 mm<sup>2</sup>. This medium power amplifier is applicable for wireless LAN applications.

Design of power amplifier based on GaAs HEMT at 2.45 GHz presented by Ravinder Kumar, Munish Kumar, Balraj [2]. This GaAs HEMT power amplifier having 34% power added efficiency(PAE) at DC supply of 3.5 V, having output power 26 dBm and power gain of 23.4 dB. This GaAs HEMT power amplifier having 13 dB input return loss and 11 dB output return loss. The proposed power amplifier has higher efficiency prviding good input and output matching. Advance design system (ADS) software used for designing of this GaAs HEMT power amplifier.

A 2.4 GHz SiGe BiCMOS power amplifier using an adaptive bias circuit presented by Wenyuan Li, Yulong Tan [3]. This SiGe BiCMOS power amplifier uses the pseudo differential structure and adaptive bias control techniques for improving the performance of power amplifier. This SiGe BiCMOS power amplifier having 27dBm output power, 24 dB power gain and 27 % power added efficiency(PAE) at 3.3 V operating voltage. when PAE is greater than 27%, output power is maximum. This SiGe BiCMOS power amplifier used in IEEE 802.11b/g WLAN, Wi-Fi Systems applications.

A GaN HEMT 2.45 GHz Class-AB RF power amplifier for wireless communication systems presented by G. Monprasert, P. Suebsombut [4]. This GaN HEMT 2.45 GHz Class-AB RF power amplifier leads to high power dissipation. This power amplifier used as a substrate material is Gallium Nitride HEMT (High Electron Mobility Transistor) with Silicon. This a GaN HEMT 2.45 GHz Class-AB RF power amplifier produces 2.9W maximum output power and PAE of 42.5 % operating at dc supply of 20 V. This GaN HEMT 2.45 GHz Class-AB RF power amplifier has large change in the value of PAE if small change in the applied dc voltage. If supply voltage change to 28 V the value of PAE is 20.8 %. By using the advantage of mentioned technologies researchers never lost interests in CMOS power amplifiers.

A single-chip dual-band power amplifier monolithic microwave integrated circuit (MMIC) operating at 3.5V single supply has developed for both WLAN 2.4GHz and 5.2GHz with IEEE 802.11b/g/a standards applications. Presented by Chien-Cheng Lin, Yu-Cheng Hsu [5]. This single-chip dual-band power amplifier uses WINS Corporation with an InGaP/GaAs HBT process. This single-chip dual-band power amplifier having low current consumption and high power added efficiency This wireless LAN power amplifier is designed using the combination of input pre-matching two-stage MMIC with active bias and and inter-stage matching networks. Also, WLAN power amplifier having gain above 20dB gain in the frequency range of 2.2GHz to 5.5GHz. This single-chip dual-band power amplifier is an ideal solution for IEEE 802.11a/b/g Wireless LAN applications.

A Doherty power amplifier for microwave radio, developed in TriQuint GaAs 0.15 um PWR pHEMT monolithic technology presented by Roberto Quaglia, Vittorio Camarchia, Tao Jiang[6]. Taped foundry was designed by TriQuint Company for design of power amplifier. This Doherty power amplifier having output power of 30.9 dBm at 24 GHz, and power-added efficiency of 38% at saturation and 20% at 6 dB of output power. This Doherty power amplifier having 12.5 dB gain. This Doherty power amplifier having High efficiency

driver stages on both the main and auxiliary branches which is designed for increasing gain with very small impact on power-added efficiency.

A Class-AB Power Amplifier (PA) integrated circuit for 2.4GHz presented by Yongbing Qian, Wenyuan Li, Zhigong Wang [7]. Two-stage topology is used for design of this Class-AB Power Amplifier. In this class-AB Power Amplifier for designing of driver design cascode topology is used for and for designing of output stage common source configuration is used. This class-AB Power Amplifier having maximum 26.2 dBm output power and Power added efficiency at the 1dB compression point is 21.2%. Operating voltage is 3.3 V. This power amplifier used in IEEE 802.11b/g wireless LAN application.

Two stage power amplifier operating at 2.4 GHz presented by K. W. Ho, H. C. Loung [8]. This two stage power amplifier designed and fabricated in CMOS 0.35um technology. In this two stage power amplifier for driving a common gate output stage a pre amplifier is used with positive feedback. This two stage power amplifier having 33% power added efficiency(PAE) and output power 18 dBm at 1V supply voltage. This power amplifier has output power of 20 dBm at 1.2 supply voltage and having 35% of power added efficiency(PAE). Common gate class E power amplifier is used To avoid the effect on scaling of supply.

A 2.4-GHz CMOS power amplifier (PA) with an output power 20 dBm using TSMC 0.25 um standard CMOS process presented by Cheng-Chi Yen, Huey-Ru Chuang [9]. This 2.4-GHz CMOS power amplifier uses an integrated diode connected to NMOS transistor shows the same function similar to linear diode. This power amplifier shows high linearity as compared with other power amplifier. This fabricated power amplifier having 20 dBm output power and 28% power-added efficiency. The main observation for this power amplifier is it uses the diode linearization technique for designing. This power amplifier shows good performance for medium power RF amplification at 2.4 GHz wireless communication.

### 3. PROPOSED METHODOLOGY

For increasing gain, power added efficiency two stage topology is implementing for designing of power amplifier. The block diagram of proposed power amplifier is shown in figure 2. The main blocks of the two stage power amplifier are driver stage and power stage. The proposed power amplifier consists of an input matching network, output matching network and inter stage matching network for impedance matching purposes. The main function of a power amplifier is to increase the power level of the signal at the input. Driver stage is the first

stage of the power amplifier use to drive the input signal. The second stage of two stage power amplifier is called as the power stage use for obtained high output power. The output power of driver stage is less as compared to the power stage. Power amplification is the main function of power stage of power amplifier. The size of transistor use in power stage is larger as compare to the size of the transistors use in the driver stage. The signal amplification is mainly depends upon the supply voltage. Proper biasing technique is essential for designing of power amplifier. Therefore proper biasing should be selected with the supply for the driver stage and the power stage.

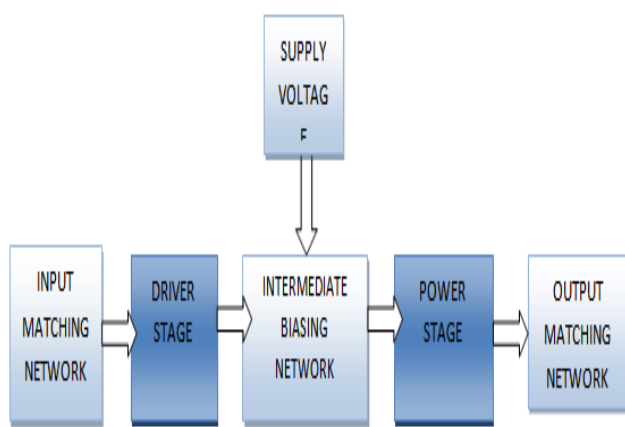


Fig -1: Block Diagram of proposed power amplifier.

#### 4. CONCLUSION

Review on power amplifier with a varying gain, output power and power added efficiency is given in this paper. We have reviewed different topologies used for providing the multi-standards in power amplifier. Different GaAs, CMOS technologies have been used for implementing the different power amplifier designs. Review has given us results of various topologies showing gain, frequency band, power added efficiency and output power as per the requirement of the application. In the future scope we will work on providing more output power, gain and power added efficiency (PAE) of power amplifier.

#### 5. REFERENCES

[1] Amiza Rasmi, A. Marzuki, M. Azmi Ismail, "Two-Stage MMIC Medium Power Amplifier using Depletion Mode PHEMT for 5.8GHz Applications", 2013IEEE.

[2] Ravinder Kumar, Munish Kumar, Balraj, "Design and Implementation of a High Efficiency CMOS Power Amplifier for Wireless Communication at 2.45 GHz", 2012 International Conference on Communication Systems and Network Technologies, 2012 IEEE.

[3] Wenyuan Li, Yulong Tan, " 2.4GHz Power Amplifier with Adaptive Bias Circuit", Institute of RF- & OE-ICs Southeast University Nanjing, China, Institute of RF- & OE-ICs Southeast University Nanjing, China, 2012 International Conference on Systems and Informatics (ICSAI 2012), 2012 IEEE.

[4] G.Monprasert, P. Suebsombut , T Pongthavornkamol, S. Chalermwisutkul, "2.45 GHz GaN HEMT Class-AB RF Power Amplifier Design for Wireless Communication Systems".

[5] Chien-Cheng Lin, Yu-Cheng Hsu, "Single-chip Dual-band WLAN Power Amplifier using InGaP/GaAs HBT".

[6] Roberto Quaglia, Vittorio Camarchia, Tao Jiang , "K-Band GaAs MMIC Doherty Power Amplifier for Microwave Radio With Optimized Driver", 2014 IEEE.

[7] Yongbing Qian, Wenyuan Li, Zhigong, " 2.4-GHz 0.18- $\mu$ m CMOS Highly Linear Power Amplifier", Institute of RF- & OE-ICs, Southeast University, 210096 Nanjing, China, the 2010 International Conference on Advanced Technologies for Communications, 2010 IEEE.

[8] K. W. Ho, H. C. Loung, "A 1-V CMOS Power Amplifier for Bluetooth Applications", 2002 IEEE.

[9] Cheng-Chi Yen, Huey-Ru Chuang, "A 0.25 $\mu$ m 20-dBm 2.4-GHz CMOS Power Amplifier With an Integrated Diode Linearizer", microwave and wireless components letters, vol. 13, no.2, February 2003, 2003 IEEE.