SI BASED DPA FOR HEATH CARE SYSTEM

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ABSTRACT

A method for designing and simulating a power amplifier in IBM 's CMOS 180 nm process is presented. This novel power amplifier is intended for sensor networks, which can be integrated at the SIP level with an objective of realizing a low cost and low power system.

KEYWORDS

Doherty Power Amplifier, linearization &sensor network

1. INTRODUCTION

Wireless Sensor Networks (WSN) can be solve variety challenge problems at many conditions[1][2][3][4]. WSNs can provide near-real time, non-stop data over a large sampling area or population by widely distributing many devices to monitor the surrounding environment[5][6][7][8][9]. WSNs deliver considerable efficiencies to otherwise costly tasks[10][11][12][13]. Such as monitoring patients to check the physical conditions, like heart rate, blood pressure[14][15][16][17]. Desirable solutions can be achieved leveraging WSNs and the current cellular communication technologies[18][19][20][21].Academic and industry research is currently investigating such frameworks[22][23][24].

A high performance but affordable device is major design challenge[25][26][27]. Many research is going on, and possible solution is to reazliede everything, analog/ RF/ digital in one chip which need tape out in Si material [28][29][30]. Need to add something what is the objective of this present work, and the potential significance of the present work[31][32][33][34].

A number of networked elements which also called sensor, and these sensors are part of the network physical node. Sensor nodes usually contain antennas, power amplifier, filters, amplifiers, ADCs and CPUs. For such sensor, cost and performance trade off is a major design challenge for medical applications [36][37][38][39]. Due to the large number of the sensor network, each node should be low cost. Each node can maintain long time working time without external source to charge[40][41][42]. Thus, it request each sensor node should be ultra-low power. Low cost and good performance, low power and good performance are essential to making such sensor node[43][44].

2. BACKGROUND

Due to the DPA characteristics they are considered to be a good candidate for replacing class AB Pas[43][44]. Table 1 shows the performance of the PAs relative to each other[43][44]. Amplifier topology is chosen based on the problem to be solved. DPAs can provide modulation bandwidth in high power outphasing and envelope tracking[45].

Table 1. DPA Comparasion.

Type	RF Band	Output Power	Mod. Band	Efficiency
Class AB	High	High	High	Low
DPA	Low	High	High	High
Outphasing	Low	High	Low	Medium
Envelope tracking	High	Medium	Low	High

High data rates with specific modulation, it is quired to have high efficiency with an excellent peak to average power ratio[45]. Class AB PAs are well suited for the maximum output power, but their efficiency is low. The DPA is highly linear using digital predistortion, making it a suitable solution for 3G and 4G handset systems. The combination of a DPA and digital predistortion can achieve high average efficiency and the required linearity[46].

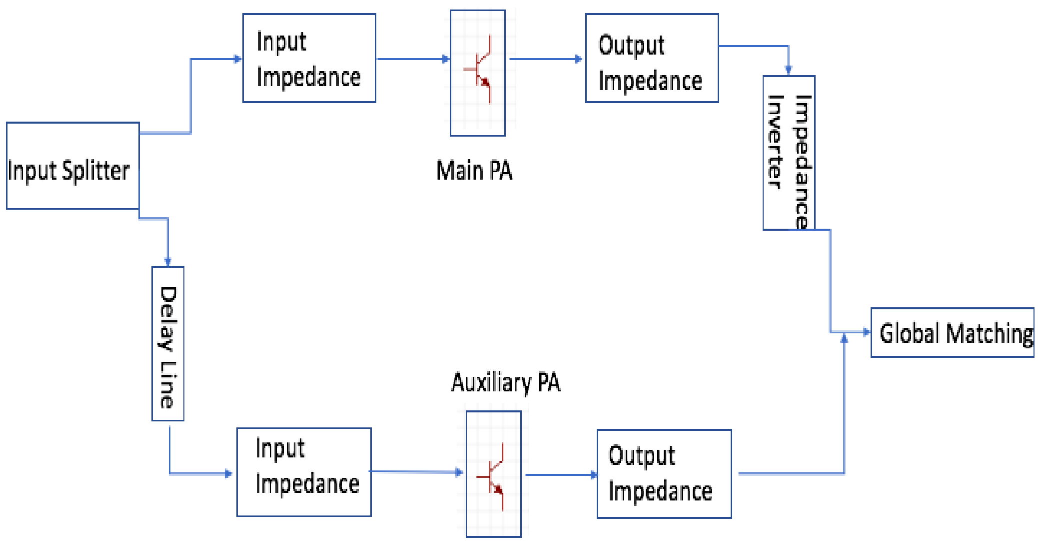


Figure1. DPA basic topology.

The DPA architecture, usually consists of two stages; the main PA, and one auxiliary PA, as seen in Figure1 [46]. A two-way symmetrical DPA topology offers improved back-off efficiency. As seen in the figure, when the input power is low the auxiliary PA is off - since the auxiliary PA biases at the class C bias point and the load is Ropt. Ropt is set for PA maximum power transfer. The main amplifier is working at class AB mode, such the load could be 2Ropt. Because of this bias, the main PA is always on, while the auxiliary PA will be on when the input power is at a specified input level. When the output power back-off (OBO) is 6 dB from maximum power, the main output voltage reaches maximum swing, also the amplifier is at maximum efficiency. Meanwhile, the auxiliary PA begins to work, injecting current into the DPA common node. Such phenomena can be seen by the power level: the output power would increase 3 dB when the auxiliary PA starts to work, however the load will be smaller until Ropt is at saturation and the DPA can maintain the maximum efficienncy while the output power is increased up to 3 dB. The purpose of the impedance inverter at the main PA is to adjust the load modulation, the phase difference could be recovered at the DPA input by inserting a delay line[46].

Table 2. DPA spec for wireless sensor network

Parameter	Size (Unit)
Frequency	0-3G
Gain (dB)	20 (dB)
Power (dB)	Low power
Supply volatage	1.8V

3. DESIGN

The main amplifiers, Z3 and Z4, are biased in class AB mode under back-off conditions, while the drain current will have high even-order harmonic components. The auxiliary amplifiers are Z1 and Z2. The choke L3 and capacitance C4 at Z4 provide low impedance at harmonic frequencies. The detailed design topology can be seen in Figure 2, and the detail design can be seen in Table 3.

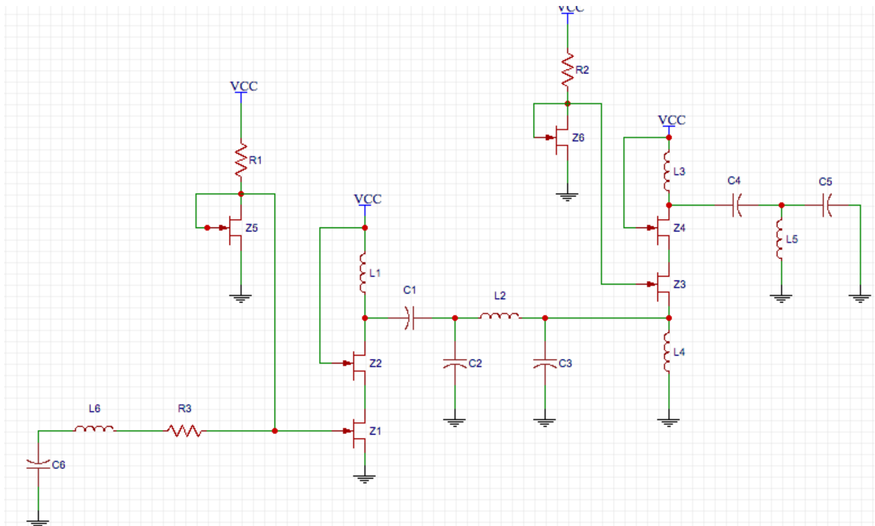
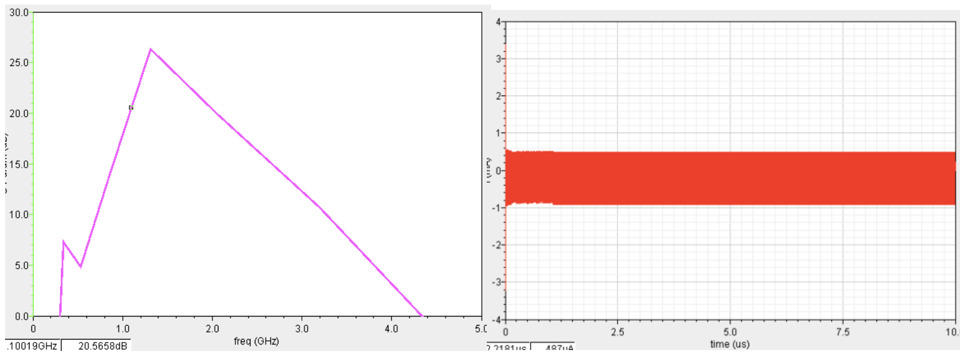


Figure 2. DPA topology of the first and second stage.

Table 3 DPA sizes

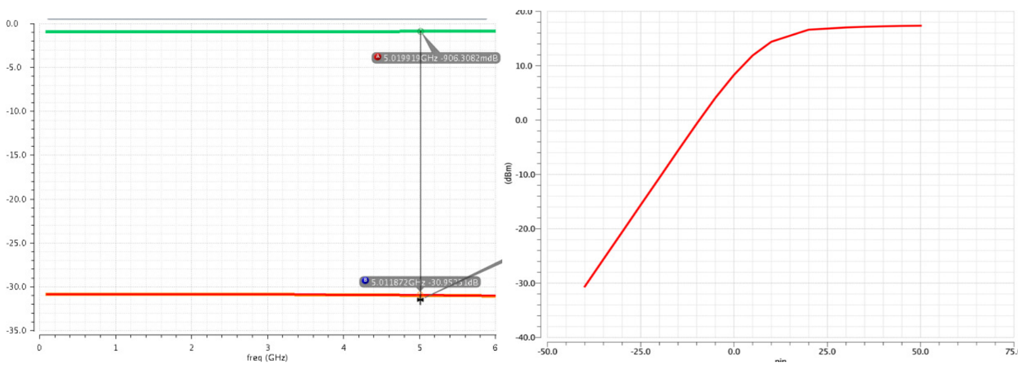
Parameter	Size (Unit)
Z1, Z3	W/L=0.6um/0.5um (f=10,m=60)
Z2, Z4	W/L=0.4um/0.5um (f=10,m=60)
Z5, Z6	W/L=0.5um/0.5um(m=60)
L1	24nH (Q=20)
L2	20nH (Q=20)
L3	24nH (Q=20)
L4	200nH (Q=20)
L5	100nH (Q=20)
L6	100Fh
C1	400Ff
C2	200Ff
C3	200Ff
C4	400Ff

4. RESULTS



(a) (b)

Figure 3. Simulation results (a) Gain vs freq (b) Current output



(a) (b)

Figure 4. Simulation results (a) S11 & S22 vs freq (b) Pout vs Pin

As seen in Figure 3 (a), the maximum gain could be reached 25 Db at 1.4G, more over at 2.4GHz, the gain could be reached 18 dB. As seen in the Figure 3 (b), the current is 1.5mA, so the totally power consumption is 2.7mW.

From Figure 4 (a),S11 is larger than -10 dB from 0 to 5 GHz, and S22 is around zero. Output power is around 20 dBm, as seen in the Figure 4 (b).

5. CONCLUSIONS

Simulation of an RF DPA using cadence software, based on IBM's SI 180nm technology process, is presented. This RF DPA can be realized at Si material, but also could reach good performance. Communication between medical sensors could help link patients and doctors[46]. Hospitalization resources could be improved by implementing low cost and low power medical devices. To realize this, future improvement is needed.

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