Improvement of Linearity and PAE of Power Amplifier by Employing Adaptive Bias Struture

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1. Introduction

The characteristics of linearity of power amplifier has degraded at maximum output power. The methods of improving the characteristics of linearity of power amplifier usually operate at class A or AB mode and backed-off of output power to accommodate a high peak-to-average ratio. However, there is tradeoff between linearity and power efficiency, and the amplifiers with a high linearity have low PAE in current wireless communication.

Usually power amplifiers operate at much lower power than its maximum output power for most of operationg time. Hence, the PAE of the power amplifier has become an important issue in handset.

There are many kinds of improving PAE of power amplifier in wireless communication: Doherty amplifier[1], stage bapassing in multistage[2], adaptive bias circuit[3]. But, these methods have been not good in the characteristics of linearity.

The PBG structure that is using the periodic discontinuous structure has the suppression characteristics on wide band frequency [4-5]. The adaptive bias of gate voltage and the PBG structure have been employed to improve PAE and the characteristics of linearity of power amplifier. The envelope of the input RF signal has been detected, and has used to control dc bias of the gate dynamically.

We designed the PBG structure and fabricated it on the ground of output matching line to improve the characteristics of linearity of the adaptive bias power amplifier. Our amplifier has been designed improving PAE and IMD of power amplifier.

2. Adaptive bias power amplifier design and manufacture

The power amplifier have been implemented using Motorola's MRF281 (4-W PEP) LDMO and the substrate is Teflon, $\varepsilon_r = 3.2$. Simulation tool has been used to the

ISBN: 89-86522-78-0 94460©KEES

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The dc bias has been V_{DD} = 26 V, I_{DD}= 250 mA for the class AB amplifier. Device MRF281 have 14dB of gain and 19dBm of P_{1dB}. Load impedance for output matching network and source impedance for input matching network have been obtained by load pull simulation with ADS, respectively.

The power gain, PAE and IMD have been 13.965 dB, 22.074% and -27.698 dBc, respectively.

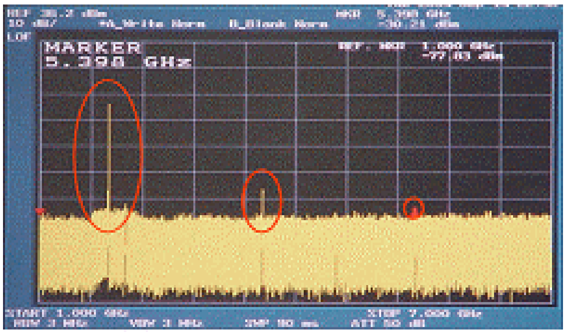

Fig.1. Harmonics of power amplifier with adaptive bias, without PBG structure.

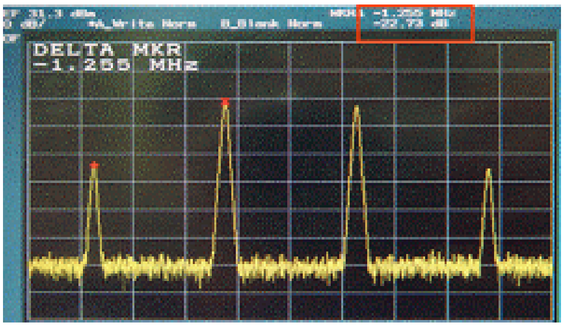

Fig.2. IMD of power amplifier with adaptive bias, without PBG structure.

Fig. 1 shows harmonic 1-tone characteristics of the adaptive bias power amplifier without PBG structure. When input power is 20 dBm, the fundamental output power, 2^{nd} harmonic output power, 3^{rd} harmonic output power have been 35.56 dB, -21.29 dBm, and -30.21 dBm, respectively.

Fig. 2 shows the measured 2-tone signals in 1.25 MHz band of the adaptive bias power amplifier without PBG structure. Output power of 2-tone signals and IMD have been 29.6 dBm/tone and -22.73 dBc, respectively.

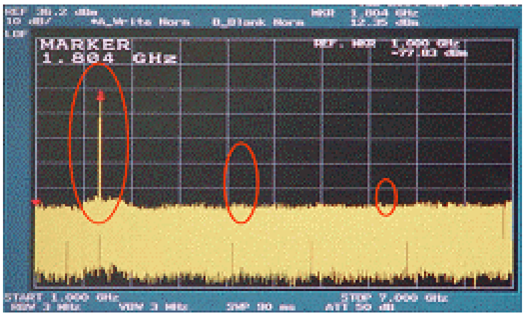

Fig.3. Harmonics of power amplifier with adaptive bias and PBG structure.

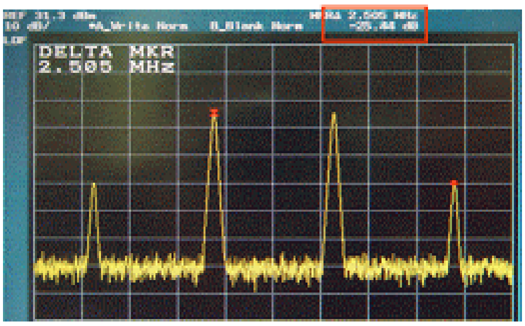

Fig.4. IMD of power amplifier with adaptive bias and PBG structure.

Fig. 3 shows harmonic 1-tone signal characteristics of the adaptive bias power amplifier with PBG structure. When input power is 20 dBm, the fundamental output power, 2nd harmonic output power, 3rd harmonic output power have been 35.35 dB, -41.5 dBm, and -50.16 dBm, respectively.

Fig. 4 shows the measured 2-tone signals in 1.25 MHz of the adaptive bias power amplifier without PBG structure. Output power of 2-tone signals and IMD have been 29.35 dBm/tone and -25.44 dBc, respectively.

The output current I_{DS} has been by controlling input voltage V_{GS}. Fig. 4. (a) shows that the output current depends on the input power

	Fixed bias power amplifier (η_F)	Adaptive bias power amplifier (η_A)
Average Power Added Efficiency (η)	10.55 %	14.30 %

Table.1. Average PAE of power amplifier. not used adaptive bias.

Table. 1 and Fig. 4. (b) shows the comparisons of PAE with fixed bias and adaptive bias of power amplifier. The improvement of average power PAE is $(\eta_A - \eta_F)/\eta_F$ = 35.54%. At the lower power levels, the adaptive bias power amplifier can control of power supply voltage optimally.

3^{rd} IMD	Adaptive bias PA without PBG	Adaptive bias PA with PBG
Input power (P_{1dB} = 20 dBm)	-22.73 dBc	-25.44 dBc

Table.3. IMD of power amplifier without PBG.

The third IMD was -22.73 dBc for the adaptive bias power amplifier without PBG and –25.44 dBc for the adaptive bias power amplifier with PBG. In conclusion, we obtained 2.74dBc improvement of the IMD at maximum input power.

5. Conclusion

In this paper, we employed the adaptive bias of gate voltage to improve PAE and the PBG structure to level up the linearity of power amplifier. The envelope of the input signal has been detected, and has used to control dc bias of the gate dynamically. The PBG structure has been optimized to suppress the second harmonic of the amplifier. We designed the PBG structure and fabricated it on the ground of output matching line to improve the linearity of power amplifier.

As a result, we obtained 35.54% of the PAE has been improved by the adaptive bias power amplifier compare with fixed bias power amplifier. The IMD has been improved 2.7dBc at same output power using PBG structure.

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