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Research on Power Amplifier Based on Envelope Tracking Technology

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Abstract. The envelope bandwidth and power peak-to-average ratio of radio frequency transmissions constantly rise as mobile communication technology advances. Traditional constant voltage power amplifiers, however, struggle to handle the power needs of modern devices. The envelope tracking power amplifier uses a dynamic voltage supply method, which can achieve a good balance between the linearity and efficiency of the power amplifier system. The essay demonstrates the fundamentals of an envelope tracking power amplifier. The power amplifier is designed using the transistor model, and simulation is done using ADS and other tool software. It is demonstrated that envelope tracking technology can increase power amplifier efficiency.

Keywords: Envelope Tracking, Power Amplifier, Efficiency.

1. Introduction

Due to the shrinking of electronic devices, current manufacturers are worried about how to make the devices last for a long time in a small space. The power amplifier element [1] controls the system's total power consumption as it is the component that uses the most energy. As a result, the direction of research has traditionally been focused on improving power amplifier efficiency.

Since the emergence of mobile communication technology in the 1970s, it has continued to develop at a rapid rate. With the rapid increase in information carried, the peak-to-average ratio of RF input signals has also been increased greatly, especially the popular fourth-generation communication technology and the ascendant fifth-generation communication technology. The linearity of power amplifiers is required strictly by new communication technologies. There are four commonly used ways to improve the efficiency of power amplifiers so far, namely envelope elimination and restoration technology [2], LINC modulation technology, envelope tracking technology [3-5] and Doherty technology [6]. In order to modulate more information within limited spectrum resources, high PAPR standards are adopted by contemporary communication, and envelope tracking technology can be controlled and adjusted between efficiency and linearity, which is given a promising prospect.

2. The fundamental of envelope tracking power amplifier

The efficiency of the power amplifier varies with the change of the output power state of the power amplifier. Therefore, in the discussion of envelope tracking technology, it is generally considered the

drain power supply to meet the saturation state of the power amplifier, and the maximum efficiency value can be obtained at this time. Therefore, through certain calculations, the drain efficiency of the power amplifier [7] can be expressed as

$$\eta = \frac{P_1}{P_0} = \frac{1}{2}\frac{I_1}{I_0}\frac{V_1}{V_{dc}} \tag{1}$$

$P_1 = \frac{1}{2} I_1 V_1$ represents the fundamental frequency output power. $P_0 = I_0 V_{dc}$ represents DC power. V_1 and I_1 represent the voltage and current amplitudes of the output fundamental wave. V_0 and I_0 represent DC voltage and DC current. When the bias point of the power amplifier is selected, its conduction angle is basically constant, and $\frac{I_1}{I_0}$ is a constant at this time. At this time, the drain efficiency of the power amplifier is only related to $\frac{V_1}{V_{dc}}$.

The power added efficiency can be expressed as

$$PAE = \left(1 - \frac{P_2}{P_1}\right) \tag{2}$$

P_1 is the input power of the signal. It can be concluded that the power added efficiency is directly proportional to the drain efficiency. The envelope tracking technology adjusts the power supply value of the drain voltage in real time according to the change of the input signal envelope.

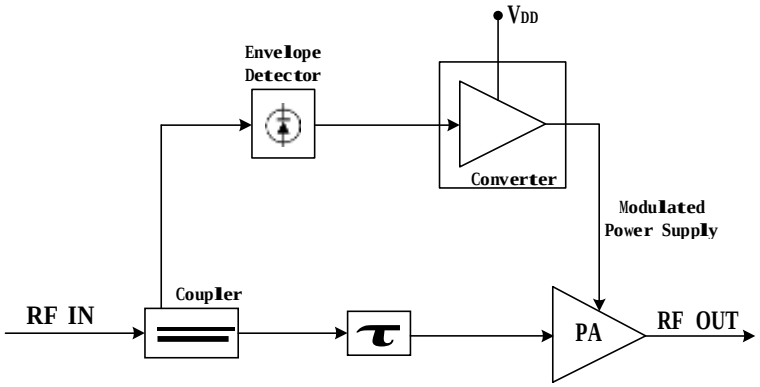

Figure 1. Basic structure of envelope tracking power amplifier.

The basic structure of envelope tracking power amplifier is shown in Figure 1 [8]. The detector is used to extract the envelope of the radio frequency input signal, and then the drain voltage control module outputs the optimized drain bias voltage by changing the signal envelope. The function of the delay line is to realize the alignment of the bias voltage and the signal.

3. Simulation

In the simulation, NE900175 transistor is selected as the core. For the class A bias operating point, the gate voltage is -1.5V, and the drain voltage is 6V. The input and output matching circuits are designed

after pulling. The performance indicator of the gain and efficiency of the power amplifier is shown in Figure 2:

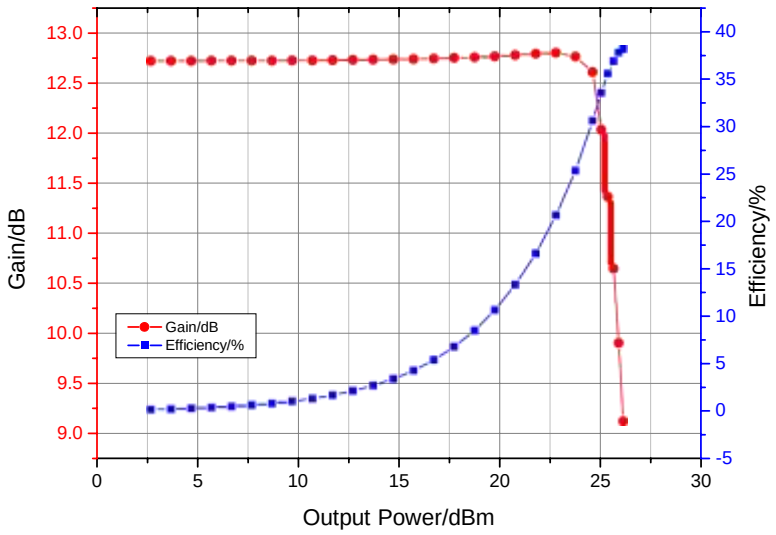

Figure 2. Efficiency and gain vs. output power.

The output power of the power amplifier is affected significantly by the drain voltage. Scanning the drain bias voltage, the change trend of the power amplifier gain and output power is shown in Figure 3. It can be found that as the drain bias voltage increases, more Maintain constant gain can be obtained at high output power. That is, as the required output power increases, the drain supply voltage is dynamically adjusted to ensure the required gain while reducing the DC loss. This is the idea of improving the efficiency of the envelope tracking power amplifier.

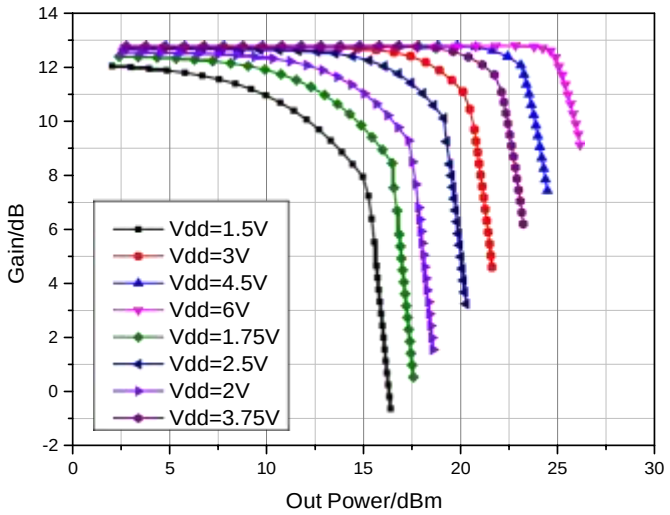

Figure 3. Efficiency and gain vs. output power.

The bias voltage value is selected appropriately when the constant gain is 11dB. Re-execute the efficiency simulation and the comparison of the efficiency image with the constant voltage power supply is shown in Figure 4. It can be found that when the output power is low, the efficiency of the power amplifier can be significantly improved by the envelope tracking technology, and unnecessary power loss can be avoided. The technology makes the power amplifier work in a saturated state as

much as possible in each area, which obviously improves the overall working efficiency of the power amplifier.

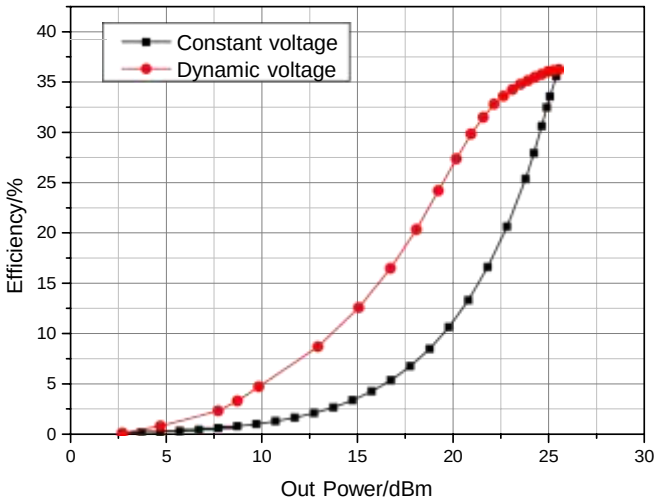

Figure 4. Comparison of efficiency vs. output power.

4. Conclusions

The article has carried on the basic introduction to the principle of the envelope tracking power amplifier, and the feasibility and effectiveness are verified in improving the efficiency of the power amplifier through ADS simulation software. It is more obvious when considered in the small signal working area. In view of the increasingly strict requirements for linearity and bandwidth of power amplifiers in today's communication systems, envelope tracking power amplifiers have good development prospects.

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