

## 2~16GHz Distributed Broadband Amplifier

Chengpeng Liu<sup>1, a</sup>, Guoqiang Wang<sup>1, b</sup>

<sup>1</sup> Sichuan Institute of Solid State Circuits China Electronics Technology Group Corp.,

Chongqing 400060, China;

<sup>a</sup>lcp54913@163.com, <sup>b</sup>wgq198202@yahoo.com

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**Abstract.** A distributed configuration for a broadband amplifier is presented in this paper. broadband amplifier has been realized by 0.2um GaAs process in ADS2011 simulator. amplifier should be designed to trade-off noise figure, gain, bandwidth, and return loss. The aims of design are to provide less ripple variation of power gain in working frequency band. The design using distributed amplifiers, and this amplifier exhibits high performance including input/output Voltage Standing Wave Ratio is lower than 2.0 over 2~16GHz. the ripple variation of power gain is less than  $\pm 0.6$ dB, the typical power gain is more than 12.8dB, noise figure is less than 3.4dB.

### 1. Introduction

Wireless communication industry has grown very rapidly in the last decade, there is a great demand for very high speed communication networks. To respond to those demands, an ultra wideband communication technique which enables wireless communications in high speed wide band together with existing wireless communication services is under development.

Broadband amplifiers have been widely used in military, communications, radar, and electronic countermeasures because of their signal amplification in a wider frequency band.

### 2. Circuit Design

With the rapid development of electronic technology, modern communication systems require high sensitivity of ultra-wideband amplifier.

Broadband microwave amplifier structure can be divided into general balanced amplifier, consumption matching amplifiers, feedback amplifier and distributed amplifiers.

#### (1) Balanced Amplifier

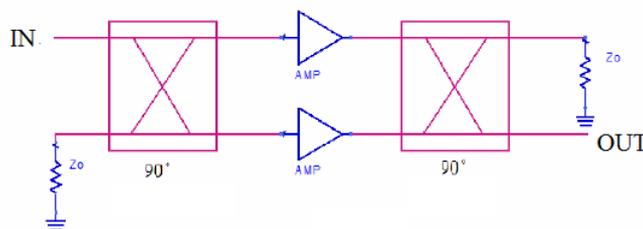


Fig.1 Balanced Amplifier

As shown in FIG.1, balanced amplifier is made up of Lange coupler and active device and matching network. Its main advantages are: a large dynamic range, hard saturation smooth and inhibit the false signal ability is very good. The input/output voltage standing wave ratio and isolation can be done very well and easily cascaded. This amplifier can do an octave or a wider bandwidth.

With the rapid development of microwave coupler technology, its working bandwidth and further expansion of space. However, the broadband matching and 3dB coupler frequency response characteristics limit the bandwidth of the balanced amplifier to several octaves or more. Second, the balanced amplifier more than ordinary single-tube amplifier used more than double the active device, which requires more bias circuit components, resulting in the cost and complexity of the amplifier circuit greatly improved, reducing the reliability of the amplifier. Balanced amplifiers also need to

provide double the DC bias power, which will limit its application in power supply is strictly limited airborne or portable devices.

(2) Consumption matching amplifier

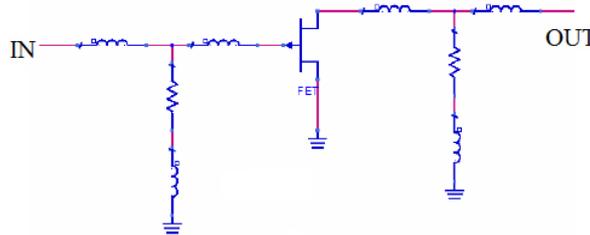


Fig.2 Consumption matching amplifier

FIG.2 shows consumption matching amplifier, it consists of input matching circuit, the middle-level matching circuit and the consumption of matching amplifier unit composed of three parts. Amplifier high-frequency side of the matching performance depends mainly on the input matching circuit and the middle-level matching circuit to improve. In actual devices, these two matching circuits are usually implemented using microstrip transmission lines. The incorporation of the lossy components enables wideband matching of the input and output of the dissipative matching amplifier unit. As the frequency increases, the gain of the field-effect transistor will decrease at a rate of about 6 dB per octave. So that the loss of the consumption of the introduction of the value of the component must be reduced with increasing frequency, the amplifier input and output loss matching circuit is usually used in consumer components and short-circuit branch of the combined network structure to ensure that will not lose too much amplifier high Frequency side of the gain. In addition, the addition of multi-section transmission line matching elements between the drain of the transistor and the resistor-loaded parallel circuit provides more improvement in the gain response characteristics of the high-frequency side of the amplifier unit. Due to the consumption of matching amplifier to introduce the consumption of components to balance the frequency response characteristics of the amplifier, while a variety of combinations of matching network and ensure the amplifier high-frequency side of the gain performance. So even a very wide bandwidth can be obtained by a good design. It is compared with the balanced amplifier, only a transistor, so the circuit structure is relatively simple, low power consumption, cost is also reduced. But the gain of the amplifier size and noise characteristics due to the introduction of consumption of components, to a certain extent affected<sup>[1]</sup>.

(3) Feedback amplifier

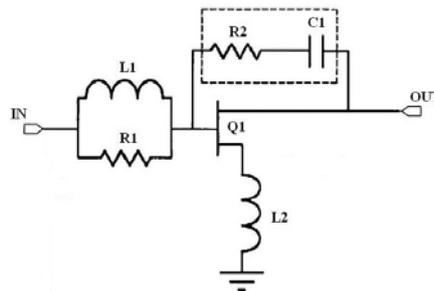


Fig.3 Feedback amplifier

Using a series or parallel resistive network to introduce positive feedback or negative feedback is the way the feedback amplifier(Fig.3) increases its bandwidth. By optimizing the choice of feedback components, the amplifier input / output matching performance can be greatly improved. Very good noise performance, input / output voltage standing wave is better, higher gain flatness and the work bandwidth can reach more than 10 octave is the advantage of feedback amplifier, the feedback amplifier is the microwave UWB amplifier with the most An important structure. But the active device parasitic parameters, feedback and bandwidth gain product still limits the bandwidth of the feedback amplifier. If the feedback is too large, the gain drop will appear to decline, if the feedback is too small, the input / output standing wave performance can not be guaranteed, thus difficult to achieve the best performance of the amplifier<sup>[2~3]</sup>.

(4) Distributed amplifier

Distributed amplifier(Fig.4) and the traveling wave tube circuit form is quite similar to the gate of a number of transistors connected to the input line, the drain is connected with the input line together. The input and output lines are generally in the form of a traveling wave. The signals are amplified while the signals are being amplified, and the two traveling waves are synchronized, and the amplified signals of the respective devices are superimposed on the output lines and output to the terminal load. Because the traveling wave nature can be maintained in a very wide frequency band, the gain flatness of the distributed amplifier can be very high, and the voltage standing wave ratio can be very low, the operating frequency band can be extended to DC DC, relatively wide frequency band To a lot of octave is no problem. The breakthrough of single-pass gain-bandwidth product-bottleneck, can be a good gain in a wide frequency band, and have a higher gain flatness, which makes the distributed amplifier into a modern electronic microwave technology research hotspot<sup>[4~6]</sup>

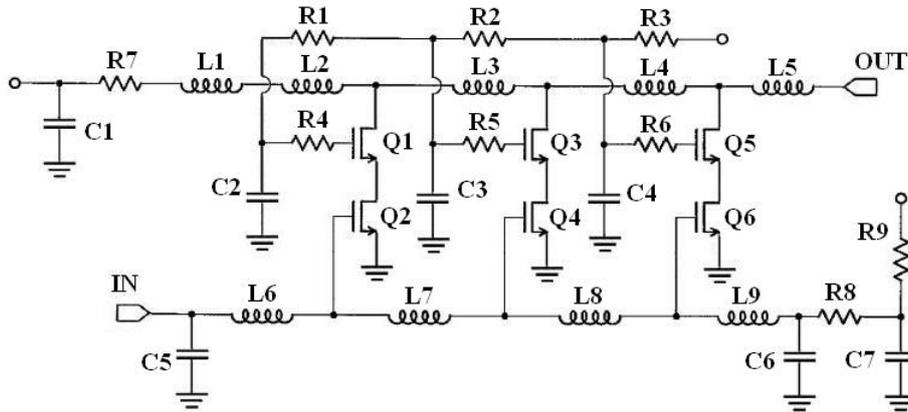


Fig.4 Structure Of distributed amplifier

Compared with other broadband amplifiers, distributed amplifiers are widely used in the design of broadband amplifiers, although they have higher power consumption and larger circuit area, but can realize wide band amplification and moderate gain and noise performance .

3. Simulation Results

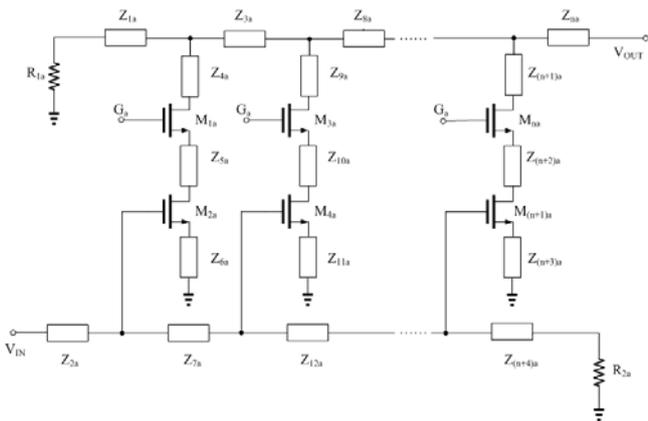


Fig.5 Broadband Distributed Amplifier



Fig.6 simulated Power Gain

Using the novel configuration, MMIC distributed broadband amplifier has been realized by 0.2um GaAs process. The simulation of our amplifier have been presented based on the ADS 2011. the proposed amplifier keeps unconditional stable(Fig.9), input/output Voltage Standing Wave Ratio is lower than 2.0 (Fig.7, Fig.8) over 2~16GHz, while consuming 63mA from 5V supply. the ripple variation of power gain is less than  $\pm 0.6$ dB, the typical power gain is more than 12.8dB (Fig.6), noise figure is less than 3.4dB (Fig.10).

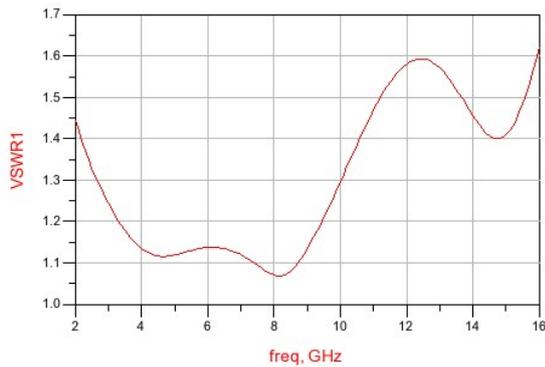


Fig.7 Input Voltage Standing Wave Ratio

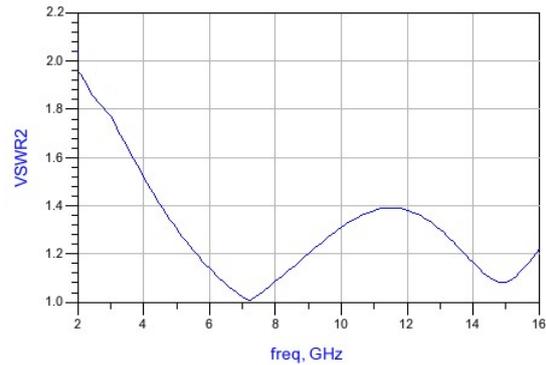


Fig.8 Output Voltage Standing Wave Ratio

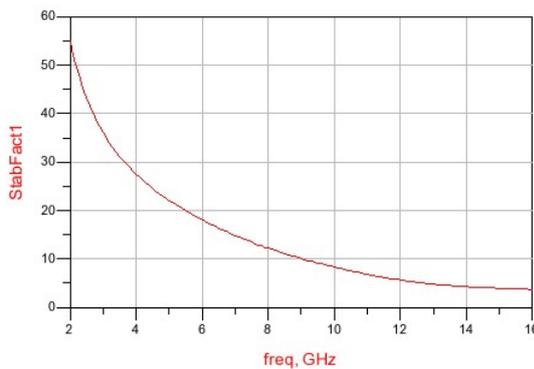


Fig.9 simulated Stable factor K

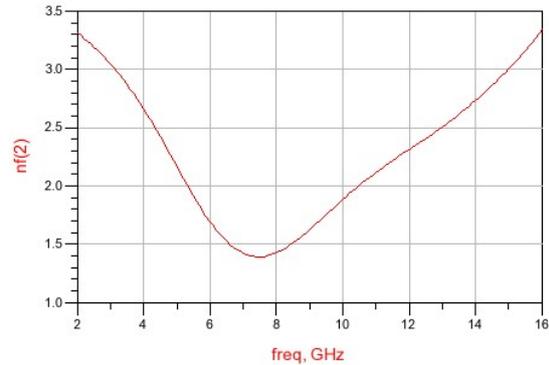


Fig.10 simulated Noise figure

#### 4. Conclusion

In this paper distributed configuration is used for a broadband amplifier. the simulated results shows a supply of 5V with 63mA. input/output Voltage Standing Wave Ratio is lower than 2.0 over 2~16GHz. the ripple variation of power gain is less than  $\pm 0.6$ dB, the typical power gain is more than 12.8dB, noise figure is less than 3.4dB. the proposed one is good candidate for broadband amplifiers applications.

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