A systematic approach to designing negative-resistance, Colpitts and VCO oscillators using p-HEMT transistor is presented. Various models such as, common source and common gate configuration in negative-resistance oscillators, common source series feedback in Colpitts oscillator, and capacitive feedback at the source and Colpitts based configuration in VCO is selected to analyze the output power and stability presented by the p-HEMT transistor. Two models at different frequencies for each of the negative-resistance and Colpitts have been designed for study and tested, with their results analyzed below. The first is at the frequency of 2.45 GHz and the second is at the frequency of 5 GHz. Further, study proved that the Colpitts oscillator designed gave more output power and stability than the negative-resistance oscillators.

1. Introduction

The oscillators are a very important component in any RF/microwave system [1]. They serve as a signal generator in the simple transmitter. In more complicated system, they are used to generate carrier signal. Oscillators are not only used in communication system, but are also employed in radars, sensors, navigation, surveillance, RF identification and medical. Hence, it is crucial to have oscillators with good output power, high dc-to-RF efficiency, low noise, good stability and good frequency tunability etc, because of their increasing demand.

In this project, to analyze the performance of p-HEMT transistor based on output power and stability, circuits have been designed with the help of ADS software. Further, these designs are fabricated into PCB and results are captured using a spectrum analyzer.

2. Designs and measured results

**Negative resistance oscillator:** Figure 1 shows the block diagram of two-port oscillator model. In this type of model, common source and common gate configurations are studied at two different frequencies of 2.45 GHz and 5 GHz, using small signal s-parameters of the p-HEMT transistor. First, the transistor at resonant frequency is chosen such that it is unstable. Second, terminating network is designed to make input impedance negative which starts oscillation in the circuit. Third, load network is constructed to sustain the oscillations until the steady state is reached. Figures 2 and 3 show the measured results of common source and common gate oscillators at the frequency of 2.45 GHz, while figures 4 and 5 show the same two configurations at 5 GHz frequency.

**Colpitts oscillator:** In this project, common source series feedback configuration is used to study the performance of the Colpitts oscillator. This configuration is selected for study because it offers a trade-off between high gain and low phase noise compared to the parallel feedback configuration. Figure 6 shows the schematic diagram of Colpitts oscillator. Here the circuit is designed using the reflection amplifier ($S_{11} > 1$). Figure 7 shows the measured result of 2.45 GHz Colpitts oscillator. 5 GHz Colpitts oscillator was not measured because the capacitor values were too small (11fF) to fabricate.

**Voltage controlled oscillator:** Two configuration of VCOs i.e., capacitive feedback at the source and Colpitts configuration are designed using varactor diodes as the tuning element. In capacitive feedback configuration, frequency tuning range of about 1 GHz with an output power of 15 dbm is obtained by changing the tuning voltage from 0-3.9 V. In Colpitts configuration, about 600 MHz frequency tuning is achieved by changing the voltage from 0-4 V.

3. Conclusion

The aim of the study was to develop a procedure for designing negative resistance oscillator, Colpitts oscillator and VCO to analyse the output power and stability based of p-HEMT transistor. The analysis showed that output power obtained from negative resistance oscillators was not optimum and oscillation frequency was shifted due to two reasons; firstly due to the design procedure, where load network was designed independent of the oscillator amplitude and secondly, due to the parasitic added while soldiering the components. In contrast, Colpitts oscillator offered high power because the p-HEMT transistor was designed as the reflection amplifier, which offered high gain to compensate the loss of resonator. In addition, it had the advantage of less shifting, as frequency was fixed by the resonant circuit components.

4. References