International Journal of Innovative Science and Modern Engineering (IJISME)
ISSN: 2319-6386 (Online), Volume-6, Issue-2, September 2019

Silicon Carbide MESFET High Frequency Oscillator for Microwave Applications

Boggadi Nagarjuna Reddy

Abstract: ***The Gouriet oscillator is mainly dealing with 4H-SiC metal semiconductor field effect transistor is fabricated with HPSI substrate and passive integrated elements are based on design for demand of the required function of frequency 1GHz. This high frequency or temperature oscillator is operated from 30 to 200˚C, the gain of the delivered power of 21.8dbm at the frequency of 1GHz and the temperature of 200˚C. The oscillator transistor output response is at 200˚C, the improved percentage is 15%. This output response of the difference in between the frequency around the vary of temperature is less than 0.5%.***

Keywords: MESFET, Silicon Carbide, Temperature, Frequency, etc.

I. INTRODUCTION

Now a days most important researchers have been focused and interested on topic is wide band gap semiconductor materials and devices [12]-[14] because of high frequency and high temperature applications in microwave engineering [15]. Wide band semiconductor devices have very less losses, high speed switching and its operates at a high temperature operations [14], [15].There is an a increasing for high frequency applications to demand the range of in between the temperature is 30˚k to 200˚k for broad band amplifiers, wideband military communications, class A and class AB amplifiers and radars. [12][13] . In all that usage of applications, wireless sensors that communicate through the Radio Frequency communication and the sensor should decrease the weight of the system and also solve the difficulty. When demand occurred for the bunch of more frequencies or high frequency that situation both wireless and wire line systems are used for high frequencies. This is one of the negative information to RF fabrication designers because of the company delivered good operation, less size, and less power value adaption, less price and fast operated and advanced low frequency and high frequency devices. Basically oscillator circuits are didn't in information systems and also used in Secure Comms for Home land Defence, CDMA, TDMA, W-CDMA and amplifiers. Therefore , this is very difficult to get that oscillators expected delivered power, peak voltage to radio frequency efficiency, occurs less noise, reduces constant stability, and decreases better frequency tuning etc, whenever demand is increasing day to day.

Whenever the demand occurred in the requirement of peak temperature and super power components are perfectly matched in these applications [4], [5].

Revised Manuscript Received on September 16, 2019
*Correspondence Author
Boggadi Nagarjuna Reddy, Ph.D scholar, high speed and frequency SiC devices and integrated circuits, at Bharath Institute of Higher Education and Research, Chennai.

The major device is dealing with the wireless communication circuit is the electronic wave generator that generates the Radio Frequency wave, and then modulate the wave and send to the major device of the framework. Multiple range frequency wave frequency depend on GaN and its executes on ambient temperature with perfect execution [6]-[8] and the N-MOS SiC oscillator wave produces executing wave 625 kHz at the temperature of 300˚C has indicated. Therefore, the mentors are intimated to the SiC MESFET differential oscillator is executed at the range of 515MHz and 125˚C with a 50Ω load [10]. Already mentioned the executed oscillator frequency is executed at the range of 1GHz and the temperature is 200˚C and the load is 50Ω. The SiC MESFET operation of the temperature measured values is depends on the frequency operated components of designed oscillator.

II. OSCILLATOR DESIGN

Gouriet frequency circuit as drawn in figure.1. In this circuit generates the variations in the oscillation frequency because of the reason of MESFET internal capacitances Cgs and Cds, are minimized. If the addition of internal and external capacitances of the transistor likes C1 and Cds, C2 and Cgs are have more capacitance and also varies the response of oscillations. Tank circuit that stored energy oscillations at the circuit, that stored or natural frequency is quickly captured because of capacitance Ct is varying. The ratio of the oscillation frequency is based on C1 and C2 capacitors to generate of natural frequency, only the sensors are affecting the capacitances.

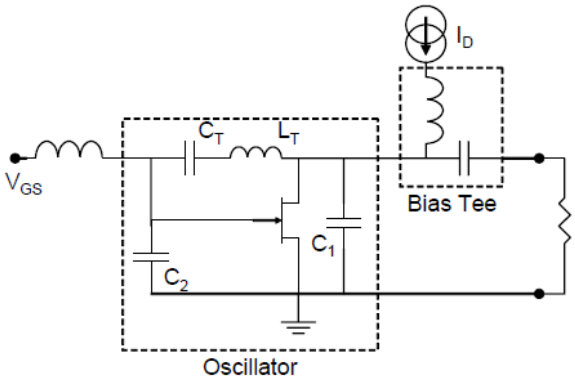

Figure.1. Design of Gouriet oscillator circuit.

The simulation result of 4H- SiC MESFET calculated parameters are temperature and frequency in the plot, using those measurements, ft is operating unity gain of transistor and fmax its operates the maximum operating oscillations at the transistor drain to source flowing current is 100mA and the drain to source bias voltage is 10V are indicated and shown in figure.2.

Retrieval Number A11410076119/2019©BEIESP
DOI: 10.35940/ijisme.A1141.096219
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MESFET is executed frequency is 1GHz at the temperature of 300˚C and MESFET internal circuit is designed along with Agilent ADS. Because of tuning purpose the integrated passive components are improved for the accurate device response for good oscillation frequency and high temperature equivalent circuit was designed. The result in figure.3. Represents the quality of integrated passive components response, and its calculated quality factor of integrated passive components at 1GHz frequency. These quality ratio decreases around 40% and 60% of quality in integrated passive components are capacitance and inductance separated when the temperature reaches to 200˚C.

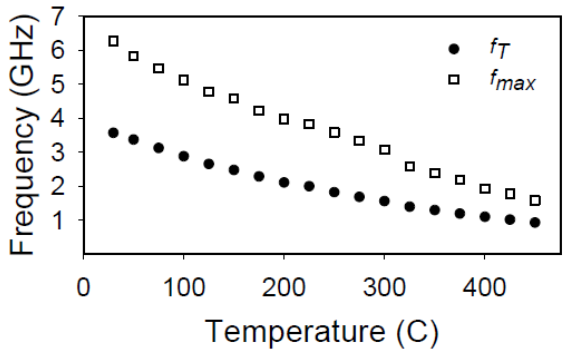

Figure.2: Transistor gain and oscillations plotted at Ids=100mA & Vds=10V.

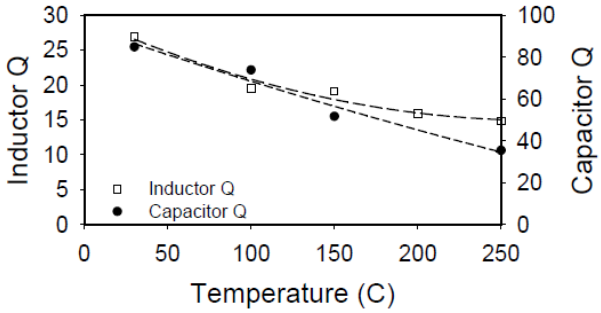

Figure.3: plotted quality of integrated circuit passive components.

The SiC MESFET oscillator circuit and integrated circuit passive components models was developed and improved at the operating frequency range 1GHz.in this fabrication, the dimension of the HPSI substrate is 254 µm and without any metallization around the substrate. But the internal circuit dimension of the metallization is 2µm. And passive components mentioned values are C1, C2 And Ct Operated values are 4pf, 4pf and 10pf, and integrated circuit passive components are respectively and the inductor is 8.5 nh Lt. The snap of the oscillator figure4.

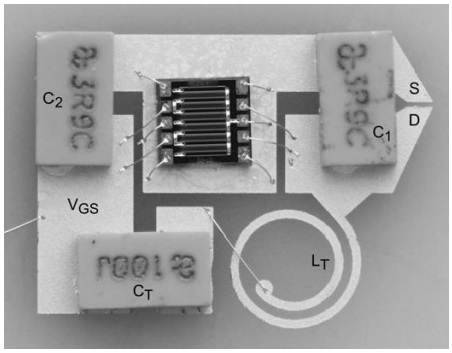

Fig.4: image of the integrated circuit passive components and transistor.

III. CALCULATION ANALYSIS

The needle DC power supply connector is taken and to biased gate to source voltage and flowing the drain to source current to ground, according to the figure.4. Less frequency connector that reduces delivered oscillating efficiency and the ground signal connector is available at right hand side of the fig.4.the ceramic heater is generates the heat for that circuit protection purpose and also its heat device controller [11], and thermocouple is measure and observe the circuit heat of the ceramic heater. So, the circuit delivered heat is always equal to the lattice heat. This frequency analyzer measures the amplitude of the RF power versus frequency and that circuit load is 50Ω. In previous result occurred losses in bias tee and connector and frequency connector is measured at the range of temperature is 30˚C, and the final result is rectified these all drawbacks with the result of 0.8dB loss.

IV. RESULTS

That oscillator output is calculated in between the delivered power (Pout) versus efficiency (η) of the oscillator drain to source current and gate to source voltage is simulated on 30˚C temperature, that result is indicated in Fig.5. in here the MESFET drain to source flowing current is 10 Ma and the bias voltage is 8V, this delivers peak drain to source current with less bias. The RF frequencies are calculated at the temperature of 30˚C, Ids is 100 mA, and bias voltage (Vds) is 10V is presented in Fig.6.

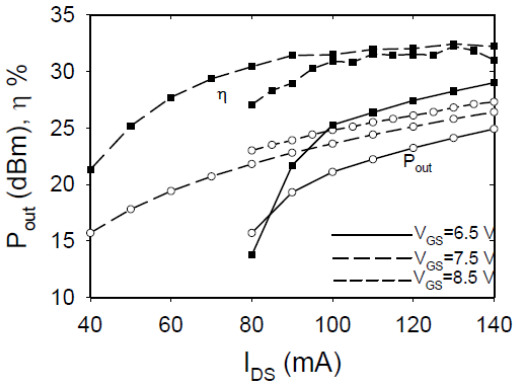

Fig.5: Simulation result is Ids vs Pout.

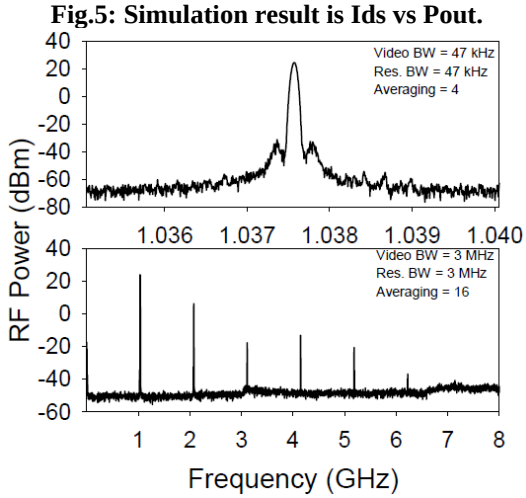

Fig.6: Calculated frequency spectrum at 30˚C.

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Absolute heat is at 20˚C, the result is a current of drain to source is 100mA and the drain to source voltage is10V, based on these values are valid on the circuit huge heat measurement. The presented results are represents the result of delivered power, efficiency, and the bias voltage (Vgs) and temperature shown in fig.7. The frequency generator oscillations are decreased gradually ceased operation at temperature of 210˚C, while the circuit operation is ended at the temperature of 180˚C in result of the simulation. First, it is noted that one of the best dealing was done in between the calculated and simulated parameters, based on the validated MESFET and passive component models. The simulated output response of the measured power decreases gradually to 25.5 to 21.8dBm and also the delivered efficiency decreases gradually 35 to 15% and the heat linearly increased 30 to 200˚C. These circuit oscillations are fluctuated with small variations at least 1.0348 GHz to peak 1.0376 GHz, at operating value is 170˚C. The fluctuation of oscillations difference is 0.5% and temperature is varied linearly 30˚C to 200˚C.

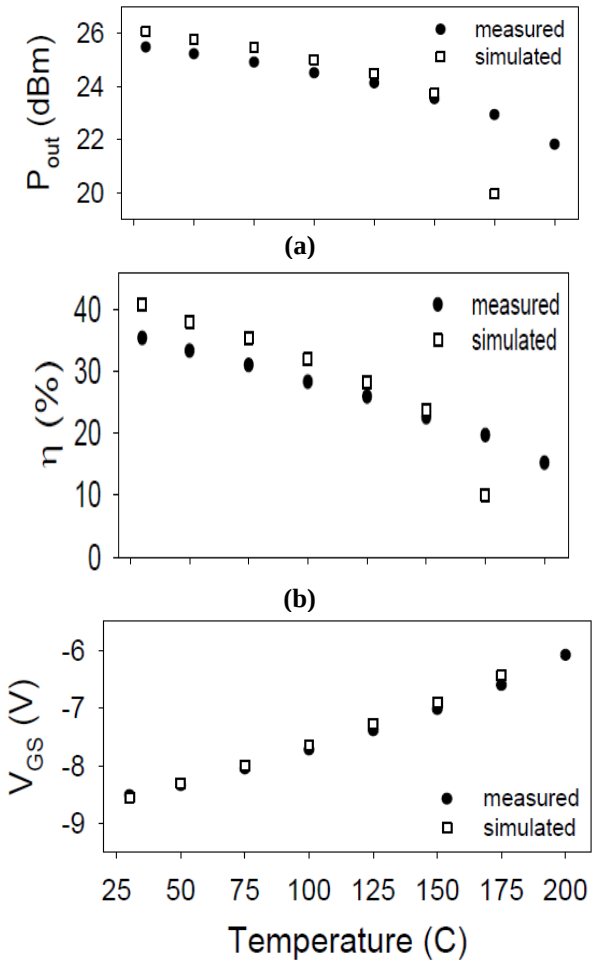

Figure.7: Analysis of oscillator parameters Pout (a), efficiency (b), and Vgs (c) respect of temperature.

The execution of the circuit is extent and by the losses is developed because of circuit elements at larger variation of temperatures. In here we are selected best performance of the oscillation tuned circuit, we trust that taken a best quality oscillation tuned circuit, this circuit is taken particular amount of heat 200˚C and also taken above valid temperatures. Whenever the circuit improvement purpose to increase the actual temperature losses occurred in circuit components, so the circuit is operated up to 300˚C.

V. CONCLUSION

This simulation result concludes the first oscillator circuit improvement and execution of the Gouriet electronic oscillator is operates temperature of 200˚C. Furthermore, finally we observe the calculated and simulated results that indicate the oscillator circuit may operate at the temperature of 300˚C based on the good performance with circuit elements.

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AUTHORS PROFILE

Boggadi Nagarjuna Reddy, was born in September 17 1988, in Kadapa. His technical journey started with Diploma in Electronics at 2003. His taken under graduate 2010 on electronics and communication engineering in JNTUniversity, Anatapur. The master degree completed 2013 on VLSI in Sathyabama university, Chennai. Currently his a Ph.D scholar and work with high speed and frequency SiC devices and integrated circuits, at Bharath Institute of Higher Education and Research, Chennai.

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