A Robust 24-29 GHz Low Noise Amplifier with 1dB Noise Figure and 23 dBm P1dB

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A 24-29 GHz low noise amplifier (LNA) microwave monolithic integrated circuit (MMIC) based on 100 nm gallium on silicon (GaN/Si) high electron mobility transistor (HEMT) process is reported in this work. The linear gain of this LNA is 25±1dB inner the band. The LNA has an average noise figure (NF) of 1 dB over the designed band and achieves the minimum value of 0.94 dB at 27 GHz. The robustness was demonstrated by overdriving the LNA with 1 Watt continuous-wave (CW) input power for 5 minutes. Compared with the traditional GaAs and InP LNA, this GaN LNA has comparable NF, much higher robustness and linearity. Moreover, this LNA is supposed to have excellent anti-irradiation ability and wide working temperature range due to the wide band gap (3.5 eV) property of GaN material. As we know, there has been no public report of GaN LNA having NF below 1 dB at this frequency region. The LNA reported in this work has a great potential in astronomy and space detection fields [1].

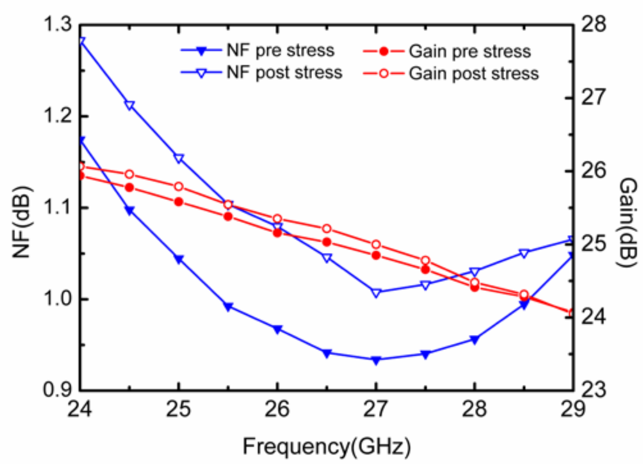

Fig. 1. Noise figure and Gain of the robust LNA measured

The LNA was designed with mixed electromagnetic and circuit simulation. The Pospiezalski model [2] based on the measured noise data was used in the circuit design. The LNA has a 3-stage cascade topology. The 4×50 um HEMT was used in the design of every state on the trade-off between robust and NF. The drain was biased at 8 Volt to achieve high linearity. A 1k Ohm resistor was used on the gate bias line of the every stage to prevent the gate finger from breakdown. The input match is critical for LNA design. To achieve the optimal noise match and input conjugate match at the same time, a source feedback was used in the design of every stage.

The measurements were conducted. The LNA has an average gain of 25±1dB in the 24-29 GHz frequency band, as the red solid line with filled circle shown in Fig.1. S11/S22 is lower than -10 dB/-18 dB inner the band. Cold source method was used as the NF measurement methodology. The LNA has an average NF of 1 dB over the designed band and achieves the minimum value of 0.94 dB at 27 GHz, as the blue solid line with filled triangle shown in Fig. 1. Additional measurements were performed for the determination of the LNA large signal performance and a preliminary evaluation of its robustness to input power. Due to the high breakdown electric field of GaN technology, a high Psat of ~28 dBm was achieved. Moreover, the 1-dB compression point output power (P1dB) of the LNA is at 23 dBm level, which indicates the high linearity of this LNA. The robustness was demonstrated by stressing the working LNA with 30 dBm CW input power at 27 GHz for 5 minutes. The NF (blue solid line with unfilled circle) and gain (red solid line with unfilled circle) after stress were measured and given in Fig. 1. It can be seen that very little change exists after stress.

GaN LNA reported in this work has low NF, high linearity and robustness. Moreover, this LNA is supposed to have excellent anti-irradiation ability and wide working temperature range. It has a great potential in the astronomy and space detection fields.

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References

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