Low noise and low power consumption with pseudomorphic HEMTs

Researchers in China show how an AlGaAs/GaAs pHEMT-based low-noise amplifier circuit has achieved the lowest power consumption while maintaining high performance.

Researchers in China have designed and constructed a two-stage 2.5–5GHz low-noise amplifier (LNA) using enhancement-mode (normally-off) aluminium gallium arsenide (AlGaAs) pseudomorphic high-electron-mobility transistors (pHEMTs) [Peng Yangyang et al, J. Semicond., vol33, p105001, 2012]. The researchers comment: "According to the author's knowledge, this is the lowest-power-consumption LNA fabricated in 0.5μm AlGaAs/GaAs pHEMT [technology] with comparable performance."

LNAs have many wireless applications such as radar (S-band 2–4GHz; C-band 4–8GHz), ultra-wideband data communications, and software-defined radios.

Gallium arsenide monolithic microwave integrated circuit (MMIC) technology competes against silicon technology and may soon have to seriously contend with gallium nitride (GaN) devices. Although silicon-based components can achieve cut-off frequencies up to 300GHz, GaAs technology is widely used in critical components for microwave and millimeter-wave application due to its greater reliability and high yield. GaN devices can achieve higher gain, but at higher cost and with higher power consumption.

Zhejiang–California Nanosystems Institute and Zhejiang University jointly developed the circuit that included on-chip capacitors and inductors, and measured 1.5mm x 1mm (Figure 1). The design aimed at flat gain over a frequency range and standard 50Ω impedance matching for the input and output. A wideband matching network and a negative feedback were used to achieve the researchers' aims of wide operation bandwidth and low noise figure.

The average small-signal gain of the circuit was 17dB with flatness of 1.6dB over the frequency range 2.5–5GHz. The input and return losses over this band

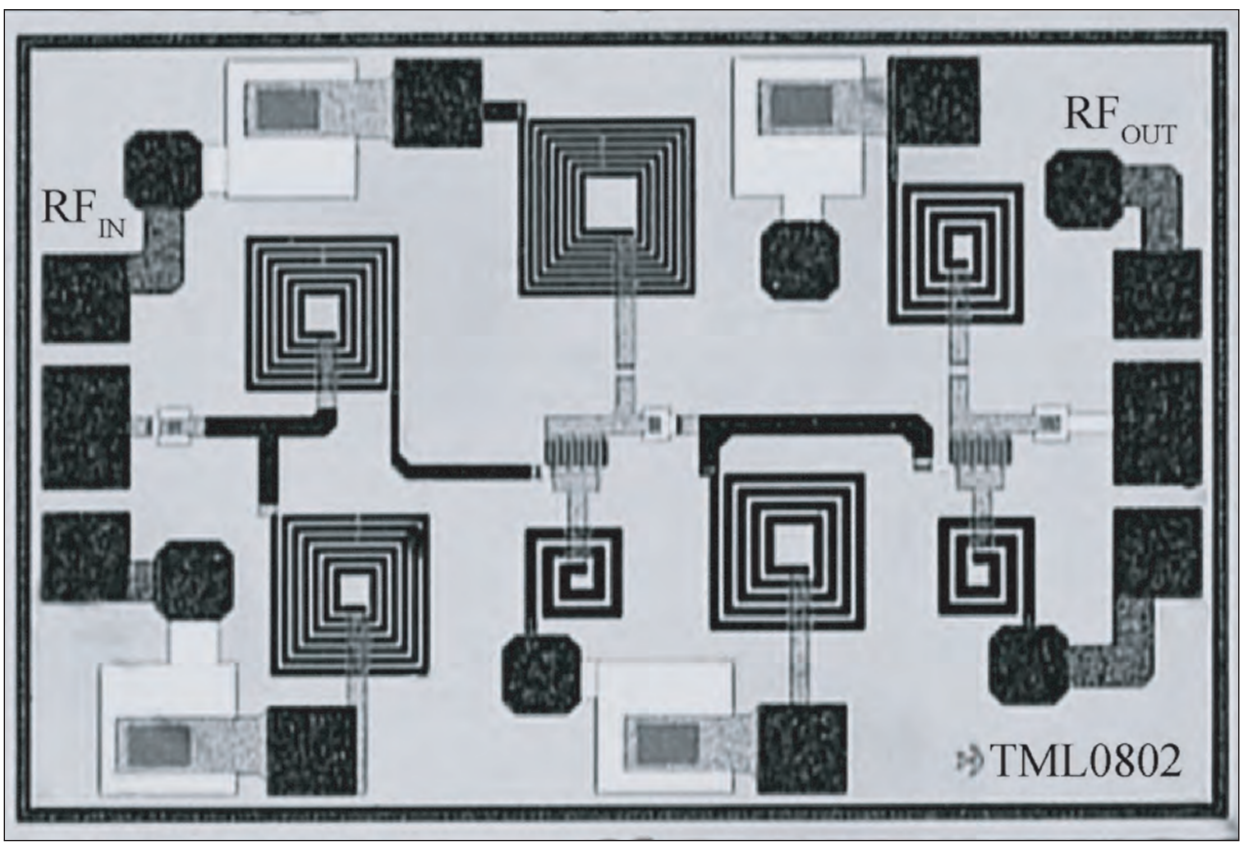

Figure 1. Chip photograph of low-noise amplifier.

were less than 10dB. The bias conditions were achieved with 1.5V power supply (V_{DD}), giving a gate bias of 0.7V and drawing a total current of 22mA (I_{DD}).

The noise figure was 2.4dB to 3dB for frequencies from 2.5GHz to 5GHz at a current bias of 33mA. From power performance measurements (Figure 2), the 1dB compression point (P1dB, the power level that causes the gain to drop by 1dB from its small-signal value) was found to be 2.3dBm with total power consumption of 33mW. Another measure of non-linearity/gain compression, the third-order intercept point (IIP3), was –2dBm. ■

http://iopscience.iop.org/1674-4926/33/10/105001

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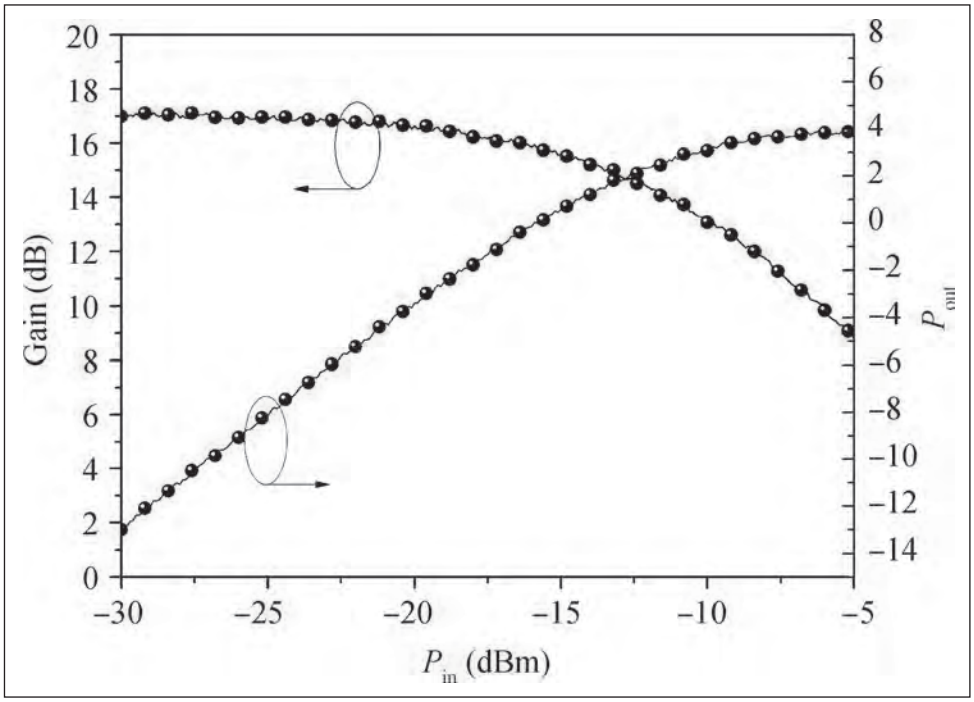

Figure 2. Power performance of the LNA at 4GHz.