(SD2018-032) Intrinsically Linear Transistor for Millimeter-Wave Low Noise Amplifiers

Tech ID: 32562 / UC Case 2018-032-0

BACKGROUND

There has been a steady rise in interest in utilizing Fin high-electron mobility transistors HEMT devices to reduce the source access resistance and enhance the linearity but this linearity is not accessible at gate voltages beyond those at which the gate Schottky diode turns on (~2 V). All known transistor technologies are intrinsically non-linear. This non-linearity leads to signal distortion and power loss. Non-linearity is embodied in a decrease of the transistor current gain cut-off frequency, fT, and maximum oscillation frequency, fmax, with an increase in the drain current.

In contrast, the patented technology here is one of a new Fin MOS-HEMT device permits flexible engineering of the device threshold voltage in order to attain linearity over a wider VGS range (voltage between transistor gate and source (VGS) in excess of the threshold voltage (Vt) where Vt is defined as the minimum).

TECHNOLOGY DESCRIPTION

Engineers from UC San Diego have patented a device architecture with potential for intrinsically tunable ultra-wide band linearity. They focused on the gallium-nitride (GaN) material because of its well-known superior physical properties of high electron mobility and saturation velocity, high sheet carrier density and high breakdown fields, all of which provide the necessary ingredients to meet the goals of high linearity and high power mm wave devices when met with innovative device layout architectures, and is one of the few – if not the only one – material choice for scalable and economical production of high linearity transmitters.

APPLICATIONS

This patented technology has the potential to replace conventional planar or Fin-HEMTs for mm-wave applications. Its intrinsically tunable capability with very wide VGS ranges allows for wideband linearity, along with high fT (FT is the "transition frequency" where current gain goes to unity) , fmax (Fmax is the frequency where unilateral gain (U) becomes unity, or zero dB) and low noise performance.

ADVANTAGES

The technology has the potential to replace conventional planar or Fin-HEMTs for mm-wave applications.

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OTHER INFORMATION

KEYWORDS

Linear, GaN, mm-wave, low noise amplifier

CATEGORIZED AS

- **Communications**
  - Wireless
- **Semiconductors**
  - Design and Fabrication

RELATED CASES

2018-032-0

· Its intrinsically tunable capability with very wide VGS ranges allows for wideband linearity, along with high fT, fmax and low noise performance.

· The disclosed multi-Fin MOS-HEMT device is expected to

1) yield linearity over wider gate voltages through the utility of multiple Fin channels,

2) open up the possibility of using low metal work function as a gate thereby enabling additional control over threshold voltage engineering for the superposition of drain currents for linearization,

3) scalability to extremely short gate lengths (20nm target) without risking substantial increases in series resistances due to the use of multi-Fin width devices,

4) the utility of advanced growth to complement the device fabrication.

STATE OF DEVELOPMENT

INTELLECTUAL PROPERTY INFO

This technology is patented in the US. Companies interested in licensing patent rights in this technology for commercial application should contact UC San Diego's Office of Innovation & Commercialization.

RELATED MATERIALS

- Intrinsically Linear Transistor for Millimeter-Wave Low Noise Amplifiers Woojin Choi, Renjie Chen, Cooper Levy, Atsunori Tanaka, Ren Liu, Venkatesh Balasubramanian, Peter M. Asbeck, and Shadi A. Dayeh Nano Letters 2020 20 (4), 2812-2820 - 03/23/2020

PATENT STATUS

Country	Type	Number	Dated	Case
Patent Cooperation Treaty	Published Application	2019089727	05/09/2019	2018-032

Additional Patent Pending

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