Northrop Grumman **Microelectronic Device Technology**

Gallium Arsenide Foundry Services

Description

Northrop Grumman provides a complete foundry service for Gallium Arsenide (GaAs) power amplifiers and control circuits within the 1-40 GHz range. The standard FET/HEMT service uses 4-inch GaAs wafers with MBE epitaxial layers and either 0.25 or 0.5µ gates generated with E-beam. This ensures quality amplifiers with state-of-the-art power and efficiency. HBT standard service is also available.

Proven Quality and Reliability

Customer-designed amplifiers and circuits are processed in the same cleanroom facility used to produce Northrop Grumman’s system devices. This leading edge facility provides complete on-wafer DC and RF test capability.

Northrop Grumman pioneered on-wafer power measurements of MMICs. All fabricated MMICs can be completely evaluated at the wafer level to provide known good die.

Northrop Grumman’s foundry process achieves maximum quality and reliability by providing:

- Device uniformity through the use of MBE GaAs material with stringently controlled doping
- MIMIC program-qualified process line
- E-beam written gates for consistent performance
- Double-recessed gates for state-of-the-art RF power performance
- SiN passivation
- Proven production history

User-Friendly, Custom Designs

First-pass success is assured for custom circuit designs using the Northrop Grumman MACRO cell approach. MACRO cells are available for FETs, HBTs, PHEMTs, and the following passive elements:

- Transmission lines
- Plated air bridge interconnects for low capacitance
- T-junctions
- Rectangular spiral inductors
- MIM capacitors
- Curves
- Bends
- Tapers
- Through wafer vias for low ground-lead inductance
- NiCr thin film resistors

Curtice model parameters are available for both FETs and HEMTs. Gummel-Poon model parameters are available for HBTs. The MACRO elements are available in EEsof™ Series IV and HP MDS 6.0 are provided with sample designs.

A foundry tutorial course can be arranged at a customer location to speed up the design cycle. The procedure for a custom design includes:

- Consultation with foundry design personnel to review design requirements
- Design and layout of circuits using MACRO elements
- Process and test of designs

GaAs MMIC Foundry Technologies 0.25µm PHEMT Features

- fT = 40 GHz
- Low noise
- Efficient RF power
- High gain
- Low DC power
- Direct-write E-beam gates, 0.25µm T-gate
- 5x stepper lithography for all other levels
- MBE, 4 inch wafers
- Profile: double heterostructure, superlattice buffer
- Channel structure: wet etched; double recess; InGaAs channel
- Substrate thickness: 4 mils
- MIM capacitors/passivation: Silicon nitride
- Two-level metal with 3µm thick airbridge plating
- Overlay metal is 2µm thick; plating is 3µm thick; bias lines can be 5µm thick
- Resistors: TiPt; active layer

PHEMT Performance Characteristics

- 30% PAE; 0.2 Watt: 6 dB assoc. gain; 0.5 mm at 30 GHz; 50% Idss bias point; Idss 350 mA/mm; Imax 600 mA/mm; Vpinchoff 1.2V; BVDGO 10V (11V typ); VDS 5V

HBT Features

- fT = 40 GHz, Vce 2V
- fT = 26 GHz, Vce 7V
- Highest linearity
- Lowest phase noise
- Low DC power
- Analog/digital integration
- Highest efficiency
- Very high circuit density
- 5x stepper lithography for all levels (I-line, 0.6µm resolution)
- MOCVD, 4-inch wafers
- Carbon-doped base, 4 x 1019cm-3, 1000 Ang thick
- Non-self-aligned process; higher Beta, lower 1/f noise than a self-aligned process
- Thermal shunt cell design; lowers thermal resistance by 40%
- Substrate thickness: 4 mils
- MIM capacitors/passivation: Silicon nitride
- Two-level metal airbridges; airbridge plating is 6µm thick
- Overlay metal is 2µm thick; plating is 6µm thick; bias lines can be 8µm thick
- Resistor: TiPt

HBT Performance Characteristics

- 55% PAE; 0.5 Watt; 9 dB assoc. gain at X-band: 2µm x 20µm x 12µm
- Class B operation where the operating current is four times the quiescent current
- Two processes: Vce 7V, Bvceo 15V; Vce 9V, Bvceo 20V
- Larger devices at lower frequencies such as C-band grow in overall length not width

MESFET Features

- Direct-write E-beam gates, 0.5µm
- 5x stepper lithography for all other levels
- MBE, 4-inch wafers
- Profile: spike doped with superlattice buffer
- Channel structure: wet etched, double recess substrate thickness: 4 mils
- MIM capacitors/passivation: silicon nitride
- Two-level metal with airbridges; airbridge plating is 3µm thick
- Overlay metal is 2µm thick; plating is 3µm thick; bias lines can be 5µm thick
- Resistors: TiPt; active layer

MESFET Performance Characteristics

- 45% PAE; 1 Watt; 9 dB assoc. gain; 2.2 mm at X-Band; 20% Idss bias point
- Idss 225 mA/mm; BVDGO 19V (20.5V typ.); Vpinchoff 2.2V; VDS 9V

Switch FET Features

- Direct-write E-beam gates, 0.5µm
- 5x stepper lithography for all other levels
- MBE, 4-inch wafers
- Profile: flat doped
- Channel structure: wet etched, single recess
- Substrate thickness: 4 mil
- MIM capacitors/passivation: Silicon nitride
- Two-level metal with airbridges; airbridge plating is 3µm thick
- Overlay metal is 3µm thick; plating is 3µm thick; bias lines can be 5µ thick
- Resistors: TiPt; active layer

Switch FET Performance Characteristics

- Ron 1.9 ohms/Coff 0.28 pF for 1 mm device; 300 GHz figure of merit (1/2 πRonCoff) Vpinchoff 4V (-5V turn off switch); BVGDO 10V (11V typ.).

Export of these devices is subject to U.S. Government Regulation.

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