Building mmWave Applications?
Learn About TriQuint’s TQP15.

For CMP Annual User’s Meeting
January 20, 2011
Commercial Foundry Business Unit

- Leading GaAs foundry in the world
- Supplier for over 25 years
- Broadest range of GaAs and GaN foundry technologies
- Unmatched support and service
Applications
- Low Noise, Power Amplifiers, VSAT, Pt-to-Pt, Converters, Ka-band PAs.

Circuit elements
- Transistor (0.15\(\mu\)m D-mode pHEMT)
- D-S connected overlap Schottky diodes
- N- epitaxial and NiCr TFR resistors (120 and 50 ohms/sq)
- MIM capacitors (0.62 fF/\(\mu\)m\(^2\))
- Spiral inductors
- 2 layer gold interconnect
- BCB planarized global interconnect
- No airbridges
- Substrate vias

Mask layers (w/o vias): 13

<table>
<thead>
<tr>
<th>Parameter</th>
<th>TYP</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>D Vp</td>
<td>-1.0</td>
<td>Volts</td>
</tr>
<tr>
<td>Idss</td>
<td>380</td>
<td>(\mu)A/(\mu)m</td>
</tr>
<tr>
<td>Imax</td>
<td>580</td>
<td>(\mu)A/(\mu)m</td>
</tr>
<tr>
<td>Gm (Idss/2)</td>
<td>550</td>
<td>mS/mm</td>
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<tr>
<td>Ft (peak)</td>
<td>80</td>
<td>GHz</td>
</tr>
<tr>
<td>Breakdown</td>
<td>14</td>
<td>Volts</td>
</tr>
</tbody>
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DC Data @ Vds = 3.0V
TQP15 Released to Full Production

- Cost-effective mmWave
  - 6”/150mm wafers
  - I-line optical stepper
  - Spacer based optical lithography

- Mature and stable process
  - Leverage high volume modules in fab
  - Thousands of wafers run on spacer formed gates at TriQuint
  - Gate module qualified on two fully released flows

- Meets performance requirements
  - Ft enables Ka-band designs
  - Idss and Bv enable power density and operating voltages for a power market
TQP15 Performance and Design Tools
24GHz Loadpull: 4x75um Device Tuned for Po Max

- 5V Power Density: 510mW/mm
- 6V Power Density: 740mW/mm

CPW Test Structure w/ 4 mil Substrate Vias

D4x50 SV: Max. Power Tune – 6V, 20mA
D4x50 SV: Max. PAE Tune – 6V, 20mA

24GHz Loadpull: 4x75um Device Tuned for Max PAE

5V Power Density: 510mW/mm
6V Power Density: 680mW/mm

Max PAE occurs at ~ P1dB
- MSG with 100 micron thickness substrate and substrate vias
- 10dB MSG at 30 GHz, usable gain up to 50 GHz
- Gain from -40°C to 100°C very well behaved
40 GHz PA Design Example

- 40 GHz power amplifier design goals
  - Push process limits for PA applications
  - >2 Watts Po
  - 15dB gain
  - Standard 100 micron substrate with vias

Simulation Results with TQS PDK
TQP15 Noise Figure and Associated Gain 2 to 26 GHz

4x50\(\mu\)m CPW test structure w/ 100\(\mu\)m substrate vias

Thick gate metal results in low Fmin and low Rn, forgiving LNA matching

![Graph showing Fmin vs. Frequency](image)

Vds=2V, Ids=20mA (25% Idss)
The design kit supports active and passive components for accurate simulation and quick and easy layout:

- FET cells
- Substrate vias
- Inductors
- Blocking caps
- Resistors
- Transmission line elements
- Bypass caps and bondpads
The design kit supports active and passive components for accurate simulation and quick and easy layout

- FET cells
- Substrate vias
- Inductors
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- Resistors
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TQP15 FET Simulation vs Measured S-Parameters
Commercializing mmWave Markets – Optical Gates

- **TQPED**
  - Ft = 27 GHz
  - Integrated WLAN, Switches

- **TQP25**
  - Ft = 55 GHz
  - Handset Switches, LNAs, PtP, Ku-band PAs

- **TQP15**
  - Ft = 80 GHz
  - VSAT, PtP, Ka-band PAs

- **TQP13**
  - Ft = 100 GHz
  - Low Noise Amplifiers, Auto Radar, WPAN, Satellite, Imaging
Cost-effective mmWave process
- 6”/150mm wafers
- I-line stepper

Mature & stable process
- Thousands of wafers run on spacer formed gates at TriQuint

Meets performance requirements
- Ft > 80GHz enabling Ka band designs
- World class power density and excellent noise figure.

Fully released process
- Design kits available now
- Prototyping and samples available now

Design kits available now

Ready to learn more? Contact CMP!