Analog Process Technologies
Analog Process Technology Roadmap

- **High-Speed BiCMOS**
  - Industry's only SiGe NPN and PNP
  - Precision thin film and capacitor
  - Low parasitic capacitance
  - SOI & SiGe

- **High-Precision Analog CMOS**
  - Lowest 1/f noise in Industry
  - Best thin film resistor and capacitor
  - 3 / 5V CMOS
  - Low parasitics

- **High-Power BiCMOS**
  - Leading edge power LDMOS
  - Industry leading Cu technology
  - Multi-voltage capability
  - Voltage-scaled DECMOS

- **High-Density Analog CMOS**
  - Dense, low power CMOS
  - Analog friendly CMOS
  - Low $V_t$ CMOS
  - Passives
  - DECMOS

- Broadest, deepest analog process technology portfolio
- Process differentiation is sustainable competitive advantage
- Advanced analog technologies use fully depreciated equipment
- New product development programs across four different process platforms
Signal Conditioning & Data Converter Needs

The Real World
- Temperature
- Pressure
- Position
- Speed
- Flow
- Humidity
- Sound
- Light

Amplifier
Data Converter
Power Management
Digital Signal Processor
Interface
Clocks & Timers

Logic

Process Needs
- Transistors
  - Speed
  - Linearity
  - Noise
- Resistors
  - Temperature coefficient
  - Linearity
  - Matching
- Capacitors
  - Linearity
  - Matching
- Technology
  - BiCom3
  - BiCom3HV
  - HPA07
  - C05
## BiCom3: High Speed Fully Complementary Bipolar SiGe Process

### Features

- **Silicon germanium (SiGe)**
  - Very fast transistors: 25GHz
  - “Ideal” transistor characteristics
- **Silicon-on-Insulator (SOI)**
  - Dramatically reduced transistor size
  - Low-voltage coefficient capacitance
- **Metal-metal capacitor**
- **Very low 1/f noise and transistor internal resistance**
- **Precision thin-film resistors**

### Benefits

- 30-50% lower power operation
- Higher speeds / Excellent Dynamic Perf.
- Reduction in package size
- Lower distortion from reduced parasitics
- Extremely low distortion
- Improved accuracy
- Improved Signal-to-Noise Ratio (SNR)
- High accuracy
- Low temperature variation
## BiCom3HV: High Speed & High Voltage
36V Bipolar SiGe Process

<table>
<thead>
<tr>
<th>Features</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>40V transistors</td>
<td>Higher voltage for industrial applications</td>
</tr>
<tr>
<td>Silicon germanium (SiGe)</td>
<td>30-50% lower power operation</td>
</tr>
<tr>
<td>- Very fast transistors: 3GHz</td>
<td>Higher speeds</td>
</tr>
<tr>
<td>- “Ideal” transistor characteristics</td>
<td></td>
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<tr>
<td>Silicon-on-Insulator (SOI)</td>
<td>70% reduction in package size</td>
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<tr>
<td>- Dramatically reduced transistor size</td>
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<tr>
<td>- Low-voltage coefficient capacitance</td>
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<tr>
<td>Very low noise</td>
<td>Improved Signal-to-Noise Ratio (SNR)</td>
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<tr>
<td>Precision thin-film resistors</td>
<td>High accuracy</td>
</tr>
<tr>
<td>Features</td>
<td>Benefits</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>0.3 µm feature sizes</td>
<td>• Higher speeds and accuracy</td>
</tr>
<tr>
<td></td>
<td>• Low CapEx requirements</td>
</tr>
<tr>
<td>5V isolated CMOS transistors</td>
<td>• Improved Signal-to-Noise Ratio (SNR)</td>
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<tr>
<td></td>
<td>• Integration of analog and digital</td>
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<tr>
<td>Very low noise</td>
<td>• Improved Signal-to-Noise Ratio (SNR)</td>
</tr>
<tr>
<td>Metal-metal capacitor</td>
<td>• 4x increase in accuracy</td>
</tr>
<tr>
<td></td>
<td>• 40% area reduction</td>
</tr>
<tr>
<td>Precision thin-film resistors</td>
<td>• Lower test costs</td>
</tr>
<tr>
<td></td>
<td>• 30% reduction in package size</td>
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</tbody>
</table>
HPA07: Better Capacitors Mean Better A/D Converters

The Most Important Component in Precision A/D Converters

Capacitor Voltage Coefficient Comparison

Error vs. Code

Conventional Process

HPA07

Output Code

Error (LSB)
C05: 0.18µm Analog Enhanced CMOS

<table>
<thead>
<tr>
<th>Features</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.18 µm feature sizes</td>
<td>High Digital Density</td>
</tr>
<tr>
<td></td>
<td>Reduced Analog Circuit Parasitics</td>
</tr>
<tr>
<td>Low voltage digital logic libraries</td>
<td>Low Power Integrated Digital Processing</td>
</tr>
<tr>
<td>Multiple voltage rating CMOS analog transistors (up to 6V)</td>
<td>Support for 5V and Li-ion battery connections</td>
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<tr>
<td></td>
<td>Optimized transistor vs voltage</td>
</tr>
<tr>
<td>Isolated CMOS transistors</td>
<td>Improved Signal-to-Noise Ratio (SNR) and Total Harmonic Distortion (THD)</td>
</tr>
<tr>
<td>Integrated resistors and capacitors optimized for analog design</td>
<td>Small die size</td>
</tr>
<tr>
<td></td>
<td>Lower total solution cost</td>
</tr>
<tr>
<td></td>
<td>Reduced package size</td>
</tr>
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# LBC7: High-Power BiCMOS Process

<table>
<thead>
<tr>
<th>Features</th>
<th>Benefits</th>
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</thead>
<tbody>
<tr>
<td>0.25 μm feature sizes</td>
<td>◆ 70% increase in gate density</td>
</tr>
<tr>
<td></td>
<td>◆ Lower CapEx requirements</td>
</tr>
<tr>
<td>30V power transistors</td>
<td>◆ Up to 70% reduction in die size</td>
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<tr>
<td></td>
<td>◆ Faster switching speeds</td>
</tr>
<tr>
<td>Thick copper power buss</td>
<td>◆ Reduction in power transistor size</td>
</tr>
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<td></td>
<td>◆ Reduction in die size</td>
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<tr>
<td>3.3V isolated CMOS</td>
<td>◆ Integration of digital, analog and power</td>
</tr>
<tr>
<td></td>
<td>functions</td>
</tr>
<tr>
<td>Rugged power transistors</td>
<td>◆ 3x improvement in reliability</td>
</tr>
<tr>
<td></td>
<td>◆ Reduction in die size</td>
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</tbody>
</table>
### Features

- **0.13 µm feature sizes**
- **20V power transistors**
- **Copper metallization**
- **1.5V isolated CMOS**
- **Dense passives**

### Benefits

- **5x increase in gate density**
- **Reduction in package size**
- **50% reduction in transistor size**
- **Integration of power and dense logic**
- **Higher gate speed**
- **Higher gate density**
- **Lower power functions**
- **Integration of analog and digital**
- **Reduction in die size**

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**A035: High-Density Analog CMOS**

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[Logo: Texas Instruments]
Summary

- Analog process technologies provide sustainable competitive advantage
- Multiple process platforms optimized individually for speed, precision, power and density
- Increasing commitment to analog process leadership