Introducing 22FDX: 22nm FD-SOI Platform

July 2015
## End Market Success Demands Optimal Technology

<table>
<thead>
<tr>
<th>Market</th>
<th>Requirements</th>
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<tbody>
<tr>
<td><strong>Consumer</strong></td>
<td>Energy Star goals and smaller form factors</td>
</tr>
<tr>
<td><em>(STB/DTV)</em></td>
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<tr>
<td><strong>Wearables</strong></td>
<td>Longer battery life and RF integration to reduce system cost</td>
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<tr>
<td><strong>IoT/Industrial</strong></td>
<td>HD image/video, integrated RF/eNVM, battery operation</td>
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<tr>
<td><em>(MPU, ISP, MCU)</em></td>
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<tr>
<td><strong>Mainstream</strong></td>
<td>Display, video, and wireless needs w/o FinFET cost</td>
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<tr>
<td><strong>Mobile</strong></td>
<td></td>
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<tr>
<td><strong>Auto/Info-</strong></td>
<td>Lower $T_j$ at 125°C ambient and better Soft Error Rate (SER)</td>
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<tr>
<td><strong>WiFi/RF</strong></td>
<td>Higher data rates at lower power</td>
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FinFET & FD-SOI Solve Different Market Needs

Bulk CMOS
- Lowest Cost
- leakage

FinFET
- High Performance

FD-SOI
- Best Power/Performance/Cost Tradeoffs
Introducing 22FDX Platform

- Industry’s first 22nm fully-depleted silicon-on-insulator (FD-SOI) technology
- Delivers FinFET-like performance and power-efficiency at 28nm cost
- Ultra-lower power consumption with 0.4 volt operation
- Software-controlled transistor body-biasing for flexible trade-off between performance and power
- Integrated RF for reduced system cost and back-gate feature to reduce RF power up to ~50%
- Enables applications across mobile, IoT and RF markets

- 70% lower power than 28HKMG
- 20% smaller die than 28nm bulk planar
- 20% lower die cost than 16/14nm
## 22FDX Platform Offerings

<table>
<thead>
<tr>
<th>Process</th>
<th>Target Markets</th>
<th>Key Capabilities</th>
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<tbody>
<tr>
<td>22FD-ulp</td>
<td>Consumer, Mainstream mobile, auto/info, wearables</td>
<td><strong>Ultra-low power: 70% lower power vs. 28nm HKMG</strong>&lt;br&gt; • FinFET-like performance, ultra low-voltage operation (~0.4V)&lt;br&gt; • Dynamic tradeoff of performance vs. power with body-biasing</td>
</tr>
<tr>
<td>22FD-ull</td>
<td>IoT, Wearables, Smartcard</td>
<td><strong>Ultra-low leakage: ~1pA/um</strong>&lt;br&gt; • Additional devices for ultra-low static leakage (~1pA/um)&lt;br&gt; • ULL SRAM w/ &lt;1pA/cell leakage&lt;br&gt; • IP for BTLE, Zigbee and Thread</td>
</tr>
<tr>
<td>22FD-uhp</td>
<td>Networking; ASICs, switches, data-centers, long-haul fiber optics</td>
<td><strong>Ultra-high performance: FinFET performance via forward body-bias and overdrive</strong>&lt;br&gt; • Overdrive support&lt;br&gt; • IP for high-performance libraries and high-speed interfaces&lt;br&gt; • MIM decoupling capacitor, Multiple 2x routing metals</td>
</tr>
<tr>
<td>22FD-rfa</td>
<td>WiFi &amp; BT Combo-connectivity LTE transceivers 3G/4G/5G</td>
<td><strong>Integrated RF and Analog: Reduced system cost and power</strong>&lt;br&gt; • Resistors, capacitors, inductors, transmission lines, transformers&lt;br&gt; • RF BEOL w/ Ultra Thick Metal stacks&lt;br&gt; • RF design enablement to leverage body-bias</td>
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Forward Body-Bias (FBB) Extends FD-SOI Flexibility

<table>
<thead>
<tr>
<th>Freq. (normalized)</th>
<th>Total Power (normalized)</th>
</tr>
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<tbody>
<tr>
<td>0.40</td>
<td>0.60</td>
</tr>
<tr>
<td>0.60</td>
<td>0.80</td>
</tr>
<tr>
<td>0.80</td>
<td>1.00</td>
</tr>
<tr>
<td>1.00</td>
<td>1.20</td>
</tr>
<tr>
<td>1.20</td>
<td>1.40</td>
</tr>
</tbody>
</table>

**Frequency vs. Total Power**

- **30% Faster**
- **50% Less Power**
- **40% Faster**
- **50% Less Power**

- **22FDX (FBB=1.5V)**
- **28HKMG**

- **50%** lower power at same frequency
- **40%** faster performance at same power
- **Low Vdd** operation (down to 0.4 volts)
- **FBB Advantage**: Software-controlled body-bias enables dynamic tradeoffs between power, performance and leakage
22FDX Case Study – Smart Watch

Next Generation Device Specification

- CPU Freq. 1.5+ GHz Vdd 0.6v
- SRAM up to 16Mb
- -25C to +85C
- Integration Path: BLE, WiFi, PMIC

<table>
<thead>
<tr>
<th>Smart Watch User Case</th>
<th>40LP</th>
<th>28SLP</th>
<th>FinFET</th>
<th>22FDX</th>
<th>22FDX +FBB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freq. @ ISO power</td>
<td>1</td>
<td>1.5</td>
<td>2.8</td>
<td>2.6</td>
<td>3.0</td>
</tr>
<tr>
<td>Battery Life (Days)</td>
<td>4.6</td>
<td>6.4</td>
<td>11.6</td>
<td>13.9</td>
<td>20.0</td>
</tr>
</tbody>
</table>

40nm wearable device today

4X battery life increase with higher performance
22FDX Enables Differentiated Customer Solutions

Server

High Performance Computing & Switching

High-end Mobile Application Processor

Wired Networking, Consumer Applications Mid-Range Smartphone

IoT, Wearables, Sensors, Low-end Smartphone

22FDX

28HPP

14LPP/LPE

28SLP
FD-SOI Ecosystem Momentum

**Foundries/IDMs**
- GLOBALFOUNDRIES
- SAMSUNG
- STI
- IBM

**Adopters**
- SONY
- freescale
- CISCO
- Ciena

**EDA/IP**
- cadence
- VeriSilicon
- Soitec
- Mentor Graphics
- dxcorr
- SunEdison
- Synopsys
- invecas
- ShinEtsu

**Industry Groups**
- Eniac
- SOI Industry Consortium
- CEA
- LETI
Summary

• Leadership position with new 22FDX FD-SOI platform
• Best combination of performance, power and cost
• Enables FinFET like performance and power efficiency at 28nm cost
• Optimized for Mobile, IoT, and RF