22FDX®
22nm FD-SOI Technology

Enabling Connected Intelligence

GLOBALFOUNDRIES 22FDX® 22nm FD-SOI (Fully-Depleted Silicon-On-Insulator) process technology platform delivers cost effective performance for connected and low power embedded applications.

22nm FD-SOI transistor technology delivers FinFET-like performance and energy-efficiency at the cost of 28nm planar technologies, including up to 70% lower power vs. 28nm. The simultaneous high $F_t$, high self gain and high current efficiency of 22FDX enables efficient, ultra low power RF/analog designs.

Target Applications and Platform Solutions

<table>
<thead>
<tr>
<th>5G, LTE and 802.11ac/ax/ad</th>
<th>IoT / MCU</th>
<th>Low/mid-tier Apps Processor</th>
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<td>Enables new RF architectures w/ 35-50% die shrink (vs. 28nm) for LTE, WiFi and other wireless applications &lt;6GHz</td>
<td>Lower dynamic &amp; leakage power (vs. 40nm) – 80% lower total power – 1pA/cell standby</td>
<td>70% lower power than 28nm</td>
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<td>Integrated mmWave PA with high PSAT via SOI-stacking</td>
<td>High performance (RF) LDMOS for integrated PA and switch (WiFi, BLE4&amp;5.0) &amp; power management</td>
<td>40-50% lower power than 28nm for RF Tx/Rx</td>
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<td>Highest $f_t/f_{max}$ for 5G / mmWave</td>
<td>Versatile eNVM in FD-SOI</td>
<td>Roadmap to 12nm FD-SOI for next gen designs</td>
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Highlights

- 22nm FD-SOI technology
  - Manufactured in state-of-the-art fab in Dresden, Germany
  - Ultra-low-power extension with 0.4V operation
  - Transistor back-gate biasing for energy-efficient trade-off between performance and power
  - Integrated RF for reduced system cost and low RF power back-gate feature to further reduce RF power up to ~50%
  - World-class $F_{max}$, self gain; very low noise figure at mmWave; FET stacking for single chip integration of high $P_{out}$, high PAE PA and switches
- Low power embedded applications
  - 5G: <6GHz and mmWave handset solutions, backhaul, base stations
  - LEO satellite communications
  - mmWave radar
  - Narrow-band IoT, Wearables
  - Mobile Applications Processors
  - Networking and WiFi
  - Automotive (ADAS, IVI)
- Comprehensive design ecosystem
  - Leverages bulk digital design flows and existing EDA tools
  - Fully enabled with foundation IP and application-specific complex IP
- Complete services and support
  - Design starter kit, MPWs, prototyping
  - Advanced packaging and test solutions, including 2.5D/3D products

FD-SOI
- Fully-Depleted Silicon-On-Insulator
- Planar process similar to bulk

Fully Depleted Channel for Low Leakage

Ultra-thin Buried Oxide Insulator

5G, LTE and 802.11ac/ax/ad IoT / MCU Low/mid-tier Apps Processor

Enables new RF architectures w/ 35-50% die shrink (vs. 28nm) for LTE, WiFi and other wireless applications <6GHz

Lower dynamic & leakage power (vs. 40nm)

- 80% lower total power
- 1pA/cell standby

70% lower power than 28nm

Integrated mmWave PA with high PSAT via SOI-stacking

High performance (RF) LDMOS for integrated PA and switch (WiFi, BLE4&5.0) & power management

40-50% lower power than 28nm for RF Tx/Rx

Highest $f_t/f_{max}$ for 5G / mmWave

Versatile eNVM in FD-SOI

Roadmap to 12nm FD-SOI for next gen designs
Technology Overview

- Four core device Vt's (FBB, RBB & eLVT)
- Two I/O Vt's @ 1.2V/1.5V/1.8V
- Full set of active and passive devices
- LDMOS (3.3V/5.0V/6.5V)
- Low power: 0.4V to 0.8V Vnom
- Reference flow for back-gate biasing
- RF BEOL /w ultra thick metal stacks
- Standard temperature range: –40°C to 125°C

IP Overview

The 22FDX Platform IP portfolio includes a wide range of silicon-proven high performance, power-optimized solutions for a broad set of applications.

### Foundation IP

<table>
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<tr>
<th>Standard Cell</th>
<th>Low power &amp; low leakage library</th>
</tr>
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<tbody>
<tr>
<td>7.5T (ULP), 8T (ULL), 12T</td>
<td>GPIO (1.2-1.8V, 3.3V), ESD, BB Gen</td>
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<tr>
<td>ROM and SRAM compiler</td>
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</tbody>
</table>

### Memory

| High density memories | NVM: Electrical Fuse / OTP |
| Low leakage SRAM | ROM |

### RF and Analog IP

| Process monitor & Temp sensor | GP and fractional PLL |
| Audio/Video DAC/ADC | High-performance Audio DAC / ADC |
| BLE | WiFi |
| LDO library | Real-time clock (RTC) DC-DC |
| DDR3/4 | LPDDR3/4 USB2/3.x |
| PCIe G1/2/3/4 | SATA I/II/III MIPI D-PHY/M-PHY |
| 12.5G SerDes | DP / HDMI 2.x |

Contact GF for IP availability.

Design and Manufacturing Ecosystem with FDXcelerator™ Partner Program

GLOBALSOLUTIONS is the sum of our internal resources and ecosystem partners, combined to efficiently enable the fastest time-to-volume.

The FDXcelerator Partner Program facilitates FDX™ SoC design, reduces time to market and minimizes development costs.

Application-optimized Platform Extensions

- Integrated RF and analog with high fT/fMAX
- WiFi & BT combo, LTE transceivers
- Low power 5G and mmWave technologies
- Ultra-low static leakage (~1pA/micron)
- ULL SRAM with <1pA/cell leakage
- IoT, Wearables, Smartcard applications
- Flexible power options as low as 0.4V
- Consumer, mobile, Auto IVI applications
- Efficient non-volatile memory and low-power cache replacement for IoT (in development)
- Grade 1 for under-the-hood automotive / industrial (in planning); Grade 2

Architected for Effective Back-gate Biasing

Technology back-gate biasing feature enables dynamic tradeoffs between power, performance and leakage and provides the greatest design flexibility.

Forward Body Bias (FBB)

- 50% lower power at same frequency (vs 28nm)
- Up to 40% faster performance at same power (vs 28nm)

Reverse Body Bias (RBB)

- Reduces leakage to 1pA/micron in standby mode

High Performance and Low Power

![Frequency vs. Total Power Chart]

- 50% Faster
- 18% Less Power
- 13% More Power

<table>
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<th>Total Power (mW)</th>
<th>Frequency (MHz)</th>
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<tr>
<td>150</td>
<td>620</td>
</tr>
<tr>
<td>210</td>
<td>800</td>
</tr>
<tr>
<td>240</td>
<td>1200</td>
</tr>
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</table>

- 28 SLP
- 14LPP

Libraries (Standard Cells Memories)

- Analog / Mixed-signal
- Processor IP
- High-speed Interfaces

Full Suite PDK, Reference Flow

- 22nm FD-SOI Process Technology
- SoC Packaging
- 2.5D and 3D Packaging

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