**SPACE-Grade Radiation-Tolerant Virtex-4QV FPGAs**

Xilinx® space-grade FPGAs offer a compelling alternative to ASIC and other one-time programmable logic technologies. The Virtex®-4QV family provides three domain-specific, radiation-tolerant sub-families, with different mixes of capabilities:

- **LX:** High-performance logic
- **SX:** Ultra-high performance signal processing
- **FX:** Embedded processing

**Large-Capacity System Integration and High-Performance in Space**

Building on the Xilinx legacy of space-grade reconfigurable FPGAs established with the Virtex and Virtex-II families, the Virtex-4QV family delivers exceptional levels of integration and performance. These devices meet the requirements of demanding applications including video, communications, radar, packet processing, and encryption.

Xilinx Virtex-4QV devices offer up to 200,000* logic cells, 10Mbit of RAM/FIFO, two built-in PowerPC® 405 processor blocks with an APU controller, 512 DSP™ slices, and four built-in Ethernet blocks. Virtex-4QV FPGAs deliver outstanding performance with 400MHz clocking, DSP slices delivering 204 GMACs at 400MHz, and 350MHz PowerPC processors, all in a single device. Flexible 800 Mbps differential I/O and 500 Mbps single-ended I/O support industry-standard and custom protocols. The APU controller in the PowerPC processor block makes it easy to integrate custom offload hardware to boost processing performance.

Special processing combined with SEE mitigation techniques and tools make it possible for aerospace designers to take advantage of all the benefits of high-performance, high-density FPGA technology. In-system reconfiguration enables engineers to make hardware design changes to enhance system functionality at any time, even after launch.

**Challenges of High-Performance Electronic Systems in Space**

- Achieving high performance and integration without incurring the costs, risk, and long development times of ASICs
- Implementing hardware changes late in the design cycle
- Ensuring reliable operation in high-radiation environments

**The Xilinx Radiation-tolerant Virtex-4QV FPGA Family Solution**

- Reconfigurable technology enables hardware design changes at any time
- Multiple sub-families provide high-performance and advanced capabilities while eliminating non-recurring engineering (NRE) expenses
- Single-chip solution for embedded computing, signal processing, communications, and control
- Guaranteed radiation tolerance for space applications
Guaranteed Radiation Tolerance

Virtex-4QV FPGAs are guaranteed for total ionizing dose and single-event latch-up immunity. Xilinx pioneered the application of SRAM-based FPGAs in high-radiation environments and together with JPL founded the Xilinx Radiation Test Consortium to conduct single-event upset (SEU) characterization and report the results. To review Consortium findings, visit: http://parts.jpl.nasa.gov/resources.htm

- **Total Ionizing Dose** – Xilinx tests each wafer lot per Method 1019 to ensure that device performance meets or exceeds the guaranteed DC electrical specification requirements, as well as AC and timing parameters at 300 krad (Si).

- **Single-Event Latchup** – The radiation-tolerant Virtex-4QV technology incorporates a thin epitaxial layer in the wafer manufacturing process for latch-up immunity. For each Virtex-4QV device type, the SEE consortium verifies latchup immunity at maximum Vcc and operating temperature, subjected to a heavy ion fluence exceeding $1\times10^7$ particles/cm$^2$, with linear energy transfer (LET) exceeding 125 MeVxcm$^2$/mg.

- **Single-Event Upset** – Xilinx conducts additional experiments in heavy ion, proton, and neutron environments in order to measure and document the susceptibility and consequence of SEU(s). The SEE Consortium oversees and validates the test methods, empirical data collected, and resulting analysis. In conjunction with the SEE Consortium, Xilinx develops beam-tested, upset mitigation solutions. For mitigation, Xilinx provides triple modular redundant reference designs, configuration memory scrubbing application notes, and the TMRTool™ for automating error-free triplication of designs destined for space.

Wide Selection of IP and Tools

To help accelerate every phase of system design, Xilinx offers a complete development ecosystem that includes: ISE™ Design Suite, the award-winning FPGA design software that helps you achieve maximum performance and rapid timing closure; the EDK embedded development kit; the XtremeDSP tools package including System Generator for DSP and AccelDSP™ synthesis tool; ChipScope™ analyzer; a library of more than 600 proven IP cores; application notes; and Xilinx training and support services.

**Virtex-4QV FPGAs Optimized For:**

<table>
<thead>
<tr>
<th>LOGIC</th>
<th>DSP</th>
<th>EMBEDDED PROCESSING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part Number</td>
<td>XQR4VX320</td>
<td>XQR4VX355</td>
</tr>
<tr>
<td>Core Voltage</td>
<td>1.2V</td>
<td>1.2V</td>
</tr>
<tr>
<td>I/O Slew</td>
<td>85.000</td>
<td>24.570</td>
</tr>
<tr>
<td>Logic Cells</td>
<td>200,448</td>
<td>55,296</td>
</tr>
<tr>
<td>CLB Flip-Flops</td>
<td>178,176</td>
<td>49,152</td>
</tr>
<tr>
<td>Maximum Distributed RAM (Kb)</td>
<td>1,802</td>
<td>384</td>
</tr>
<tr>
<td>Block RAM (18K each)</td>
<td>320</td>
<td>232</td>
</tr>
<tr>
<td>Total Block RAM (Kb)</td>
<td>5,048</td>
<td>5,760</td>
</tr>
<tr>
<td>Digital Clock Manager (OCM)</td>
<td>12</td>
<td>20</td>
</tr>
<tr>
<td>Maximum Single-Ended I/Os</td>
<td>960</td>
<td>576</td>
</tr>
<tr>
<td>Maximum Differential I/O Ports</td>
<td>480</td>
<td>288</td>
</tr>
<tr>
<td>Digitally Controlled Impedance</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>DSP Sizes</td>
<td>96</td>
<td>512</td>
</tr>
<tr>
<td>10/100/1000 Ethernet MAC Blocks</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>PowerPC Processor Blocks</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Speed Grades</td>
<td>-10</td>
<td>-10</td>
</tr>
<tr>
<td>Configuration Memory (MB)</td>
<td>51.4</td>
<td>22.7</td>
</tr>
<tr>
<td>Manufacturing Grades</td>
<td>V</td>
<td>V</td>
</tr>
<tr>
<td>Total Ionizing Dose (krad)</td>
<td>300</td>
<td>300</td>
</tr>
<tr>
<td>SEL immunity (MeV-cm²/mg)</td>
<td>&gt;125</td>
<td>&gt;125</td>
</tr>
</tbody>
</table>

* Radiation tolerance requires triple modular redundancy; the logic cell capacity, therefore, must take into account triplication of all inputs, feedback logic, and outputs, as well as the voters that must be inserted on feedback and output paths.

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