Stratix® II devices offer hot socketing, which is also known as hot plug-in or hot swap, and power sequencing support without the use of any external devices. You can insert or remove a Stratix II board in a system during system operation without causing undesirable effects to the running system bus or the board that was inserted into the system.

The hot socketing feature also removes some of the difficulty when you use Stratix II devices on printed circuit boards (PCBs) that also contain a mixture of 5.0-, 3.3-, 2.5-, 1.8-, 1.5- and 1.2-V devices. With the Stratix II hot socketing feature, you no longer need to ensure a proper power-up sequence for each device on the board.

The Stratix II hot socketing feature provides:

■ Board or device insertion and removal without external components or board manipulation
■ Support for any power-up sequence
■ Non-intrusive I/O buffers to system buses during hot insertion

This chapter also discusses the power-on reset (POR) circuitry in Stratix II devices. The POR circuitry keeps the devices in the reset state until the VCC is within operating range.

Stratix II devices offer hot socketing capability with all three features listed above without any external components or special design requirements. The hot socketing feature in Stratix II devices allows:

■ The device can be driven before power-up without any damage to the device itself.
■ I/O pins remain tri-stated during power-up. The device does not drive out before or during power-up, thereby affecting other buses in operation.
■ Signal pins do not drive the VCCIO, VCCPD, or VCCINT power supplies. External input signals to I/O pins of the device do not internally power the VCCIO or VCCINT power supplies of the device via internal paths within the device.
Devices Can Be Driven Before Power-Up

You can drive signals into the I/O pins, dedicated input pins and dedicated clock pins of Stratix II devices before or during power-up or power-down without damaging the device. Stratix II devices support any power-up or power-down sequence (V\text{CCIO}, V\text{CCINT}, and V\text{CCPD}) in order to simplify system level design.

I/O Pins Remain Tri-Stated During Power-Up

A device that does not support hot-socketing may interrupt system operation or cause contention by driving out before or during power-up. In a hot-socketing situation, Stratix II device's output buffers are turned off during system power-up or power-down. Stratix II device also does not drive out until the device is configured and has attained proper operating conditions.

Signal Pins Do Not Drive the V\text{CCIO}, V\text{CCINT} or V\text{CCPD} Power Supplies

Devices that do not support hot-socketing can short power supplies together when powered-up through the device signal pins. This irregular power-up can damage both the driving and driven devices and can disrupt card power-up.

Stratix II devices do not have a current path from I/O pins, dedicated input pins, or dedicated clock pins to the V\text{CCIO}, V\text{CCINT}, or V\text{CCPD} pins before or during power-up. A Stratix II device may be inserted into (or removed from) a powered-up system board without damaging or interfering with system-board operation. When hot-socketing, Stratix II devices may have a minimal effect on the signal integrity of the backplane.

\[ \text{You can power up or power down the V_{CCIO}, V_{CCINT}, and V_{CCPD} pins in any sequence. The power supply ramp rates can range from 100 \mu s to 100 ms. All V_{CC} supplies must power down within 100 ms of each other to prevent I/O pins from driving out. During hot socketing, the I/O pin capacitance is less than 15 pF and the clock pin capacitance is less than 20 pF. Stratix II devices meet the following hot socketing specification.} \]

- The hot socketing DC specification is: |I_{IOPIN}| < 300 \mu A.
- The hot socketing AC specification is: |I_{IOPIN}| < 8 mA for 10 ns or less.
IOPIN is the current at any user I/O pin on the device. This specification takes into account the pin capacitance, but not board trace and external loading capacitance. Additional capacitance for trace, connector, and loading needs must be considered separately. For the AC specification, the peak current duration is 10 ns or less because of power-up transients. For more information, refer to the Hot-Socketing & Power-Sequencing Feature & Testing for Altera Devices white paper.

A possible concern regarding hot-socketing is the potential for latch-up. Latch-up can occur when electrical subsystems are hot-socketed into an active system. During hot-socketing, the signal pins may be connected and driven by the active system before the power supply can provide current to the device’s VCC and ground planes. This condition can lead to latch-up and cause a low-impedance path from VCC to ground within the device. As a result, the device extends a large amount of current, possibly causing electrical damage. Nevertheless, Stratix II devices are immune to latch-up when hot-socketing.

Hot Socketing
Feature Implementation in Stratix II Devices

The hot socketing feature turns off the output buffer during the power-up event (either VCCINT, VCCIO, or VCCPD supplies) or power down. The hot-socket circuit will generate an internal HOTSCKT signal when either VCCINT, VCCIO, or VCCPD is below threshold voltage. The HOTSCKT signal will cut off the output buffer to make sure that no DC current (except for weak pull up leaking) leaks through the pin. When VCC ramps up very slowly, VCC is still relatively low even after the POR signal is released and the configuration is finished. The CONF_DONE, nCEO, and nSTATUS pins fail to respond, as the output buffer can not flip from the state set by the hot socketing circuit at this low VCC voltage. Therefore, the hot socketing circuit has been removed on these configuration pins to make sure that they are able to operate during configuration. It is expected behavior for these pins to drive out during power-up and power-down sequences.

Each I/O pin has the following circuitry shown in Figure 4–1.
The POR circuit monitors $V_{CCINT}$ voltage level and keeps I/O pins tristated until the device is in user mode. The weak pull-up resistor (R) from the I/O pin to $V_{CCIO}$ is present to keep the I/O pins from floating. The 3.3-V tolerance control circuit permits the I/O pins to be driven by 3.3 V before $V_{CCIO}$ and/or $V_{CCINT}$ and/or $V_{CCPD}$ are powered, and it prevents the I/O pins from driving out when the device is not in user mode. The hot socket circuit prevents I/O pins from internally powering $V_{CCIO}$, $V_{CCINT}$, and $V_{CCPD}$ when driven by external signals before the device is powered.

Figure 4–2 shows a transistor level cross section of the Stratix II device I/O buffers. This design ensures that the output buffers do not drive when $V_{CCIO}$ is powered before $V_{CCINT}$ or if the I/O pad voltage is higher than $V_{CCIO}$. This also applies for sudden voltage spikes during hot insertion. There is no current path from signal I/O pins to $V_{CCINT}$ or $V_{CCIO}$ or $V_{CCPD}$ during hot insertion. The $V_{PAD}$ leakage current charges the 3.3-V tolerant circuit capacitance.
Power-On Reset Circuitry

Stratix II devices have a POR circuit to keep the whole device system in reset state until the power supply voltage levels have stabilized during power-up. The POR circuit monitors the $V_{CCINT}$, $V_{CCIO}$, and $V_{CCPD}$ voltage levels and tri-states all the user I/O pins while $V_{CC}$ is ramping up until normal user levels are reached. The POR circuitry also ensures that all eight I/O bank $V_{CCIO}$ voltages, $V_{CCPD}$ voltage, as well as the logic array $V_{CCINT}$ voltage, reach an acceptable level before configuration is triggered. After the Stratix II device enters user mode, the POR circuit continues to monitor the $V_{CCINT}$ voltage level so that a brown-out condition during user mode can be detected. If there is a $V_{CCINT}$ voltage sag below the Stratix II operational level during user mode, the POR circuit resets the device.

When power is applied to a Stratix II device, a power-on-reset event occurs if $V_{CC}$ reaches the recommended operating range within a certain period of time (specified as a maximum $V_{CC}$ rise time). The maximum $V_{CC}$ rise time for Stratix II device is 100 ms. Stratix II devices provide a dedicated input pin (PORSEL) to select POR delay times of 12 or 100 ms during power-up. When the PORSEL pin is connected to ground, the POR time is 100 ms. When the PORSEL pin is connected to $V_{CC}$, the POR time is 12 ms.
Table 4–1 shows the revision history for this chapter.

### Table 4–1. Document Revision History

<table>
<thead>
<tr>
<th>Date and Document Version</th>
<th>Changes Made</th>
<th>Summary of Changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>May 2007, v3.2</td>
<td>Moved the Document Revision History section to the end of the chapter.</td>
<td>—</td>
</tr>
<tr>
<td>April 2006, v3.1</td>
<td>● Updated “Signal Pins Do Not Drive the VCCIO, VCCINT or VCCPD Power Supplies” section.</td>
<td>● Updated hot socketing AC specification.</td>
</tr>
</tbody>
</table>
| May 2005, v3.0            | ● Updated “Signal Pins Do Not Drive the VCCIO, VCCINT or VCCPD Power Supplies” section.  
 ● Removed information on ESD protection. | — |
| January 2005, v2.1        | Updated input rise and fall time. | — |
| July 2004, v1.1           | ● Updated all tables.  
 ● Added tables. | — |