


Altera® HardCopy® IV devices and Stratix® IV devices are manufactured with the same process technology—they are based on a 0.9 V, 40 nm process. HardCopy IV unused logic, memory blocks, or clock trees may be powered down depending on your design utilization. HardCopy IV power is typically reduced from the Stratix IV FPGA prototype.

This chapter contains the following sections:

- “HardCopy IV Device External Power Supply Requirements”
- “Supporting HardCopy IV and Stratix IV Power Supplies” on page 11–3
- “HardCopy IV Power Optimization” on page 11–4
- “Temperature Sensing Diode (TSD)” on page 11–4
- “External Pin Connections” on page 11–4

## HardCopy IV Device External Power Supply Requirements

This section describes the different external power supplies you need to power HardCopy IV devices. Table 11–1 lists the external power supply pins for HardCopy IV E devices. You can supply some of the power supply pins with the same external power supply, provided their supply voltage levels are the same.

 For a comprehensive definition and usage guide of all HardCopy IV power pins, refer to the [Pin Connection Guidelines](#).

**Table 11–1. Power Supply Requirements for HardCopy IV E Devices (Part 1 of 2)**

Power Supply Pin (1)	Stratix IV Voltage Value (V)	HardCopy IV E Voltage Value (V)	Description
VCC	0.9	0.9	Core voltage and periphery circuitry power supply
VCCIO	1.2 / 1.5 / 1.8 / 2.5 / 3.0	1.2 / 1.5 / 1.8 / 2.5 / 3.0	I/O power supply
VCCPGM	1.8 / 2.5 / 3.0	1.8 / 2.5 / 3.0	Configuration pins power supply
VCCPD (2)	2.5 / 3.0	2.5 / 3.0	I/O pre-driver power supply
VCCA_PLL	2.5	2.5	PLL analog global power to the PLL regulator
VCCD_PLL	0.9	0.9	PLL digital global power supply
VCC_CLKIN	2.5	2.5	Differential clock input pins power supply (top and bottom I/O banks only)
VCCBAT	3.0	— (4)	Battery back-up power supply for design security volatile key register
VCCPT	1.5	— (4)	Power supply for programmable power technology (3)
VCCAUX	2.5	2.5	Power supply for the temperature sensing diode and POR

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**Table 11-1. Power Supply Requirements for HardCopy IV E Devices (Part 2 of 2)**

Power Supply Pin (1)	Stratix IV Voltage Value (V)	HardCopy IV E Voltage Value (V)	Description
VREF	VREF	VREF	Voltage-referenced I/O standards power supply
GND	GND	GND	Ground

**Notes to Table 11-1:**

- (1) There is one  $V_{REF}$  pin per I/O bank. Use an external power supply or a resistor divider network to supply this voltage.
- (2)  $V_{CCPD}$  can be either 2.5 V or 3.0 V. For a 3.0-V I/O standard,  $V_{CCPD} = 3.0$  V. For a 2.5 V I/O standard and below,  $V_{CCPD} = 2.5$  V.
- (3) HardCopy IV E devices do not require programmable power technology.
- (4) You can disconnect this power pin or leave it connected on the board.

Table 11-2 lists the external power supply pins for HardCopy IV GX devices.

**Table 11-2. External Power Supply Requirements for HardCopy IV GX Devices (Note 1) (Part 1 of 2)**


Power Supply Pin	Stratix IV GX Voltage Value (V)	HardCopy IV GX Voltage Value (V)	Description
VCC	0.9	0.9	Core voltage and periphery circuitry power supply
VCCD_PLL	0.9	0.9	PLL digital power supply
VCCA_PLL	2.5	2.5	PLL analog power supply
VCCAUX	2.5	2.5	Auxiliary supply for programmable power technology
VCCPT	1.5	— (3)	Power supply for programmable power technology (2)
VCCPGM	1.8 / 2.5 / 3.0	1.8 / 2.5 / 3.0	Configuration pins power supply
VCCPD	2.5 / 3.0	2.5 / 3.0	I/O pre-driver power supply
VCCIO	1.2 / 1.5 / 1.8 / 2.5 / 3.0	1.2 / 1.5 / 1.8 / 2.5 / 3.0	I/O power supply
VCC_CLKIN	2.5	2.5	Differential clock input pins power supply (top and bottom I/O banks only)
VCCBAT	1.2 – 3.0	— (3)	Battery back-up power supply for design security volatile key register
VREF	$V_{CCIO} / 2$	$V_{CCIO} / 2$	Voltage-referenced I/O standards power supply (2)
GND	GND	GND	Ground
VCCHIP_L	0.9	0.9	Transceiver HIP digital power (left side)
VCCHIP_R	0.9	0.9	Transceiver HIP digital power (right side)
VCCT_L	1.1	1.1	Transmitter power (left side)
VCCT_R	1.1	1.1	Transmitter power (right side)
VCCR_L	1.1	1.1	Receiver power (left side)
VCCR_R	1.1	1.1	Receiver power (right side)
VCCA_L	2.5 / 3.0	2.5 / 3.0	Transceiver high voltage power (left side)
VCCA_R	2.5 / 3.0	2.5 / 3.0	Transceiver high voltage power (right side)
VCCH_GXBL	1.4 / 1.5	1.4 / 1.5	Transceiver output buffer power for each transceiver block (left side)
VCCL_GXBR	1.4 / 1.5	1.4 / 1.5	Transceiver output buffer power for each transceiver block (right side)
VCCL_GXBL	1.1	1.1	Transceiver clock power for each transceiver block (left side)

**Table 11–2. External Power Supply Requirements for HardCopy IV GX Devices (Note 1) (Part 2 of 2)**

Power Supply Pin	Stratix IV GX Voltage Value (V)	HardCopy IV GX Voltage Value (V)	Description
VCC <sub>H_GXBR</sub>	1.1	1.1	Transceiver clock power for each transceiver block (right side)


**Notes to Table 11–2:**

- (1) HardCopy IV GX devices do not require programmable power technology.
- (2) If you do not use the  $V_{REF}$  pins, you must connect them to either  $V_{CCIO}$  in the same bank or GND.
- (3) You can disconnect this power pin or leave it connected on the board.

 For possible values of each power supply, refer to the *DC and Switching Characteristics of HardCopy IV Devices* chapter.

### 3.3-V I/O Standard Support

Stratix IV and HardCopy IV devices support up to 3.3-V I/O voltage standard using a bank supply voltage ( $V_{CCIO}$ ) of 3.0 V.

 For more information about 3.3-V I/O standards, refer to the *I/O Features in HardCopy IV Devices* chapter.


Although HardCopy IV devices support up to 3.0-V power supplies, HardCopy IV 3.0-V I/Os can properly interface with 3.3-V external ports with little loss in noise margin, given similar input and output voltage electrical characteristics.

## Supporting HardCopy IV and Stratix IV Power Supplies

The core power rails in Stratix IV and HardCopy IV devices are  $V_{CC}$  and  $V_{CCD\_PLL}$ . Both the Stratix IV and HardCopy IV core power rails are powered by a 0.9-V source. [Table 11–3](#) lists the core voltage requirements for these devices.

**Table 11–3. Core Voltage Requirements for Stratix IV and HardCopy IV Devices**

Symbol	Parameter	Stratix IV Devices	HardCopy IV Devices	Unit
$V_{CC}$	Core voltage and periphery circuitry power supply	0.9	0.9	V
$V_{CCD\_PLL}$	PLL digital power supply	0.9	0.9	V

 Stratix IV-to-HardCopy IV device mapping requires all core voltages to be 0.9-V for both Stratix IV and HardCopy IV devices. For a comprehensive definition and usage guide of all HardCopy IV power pins, refer to the *Pin Connection Guidelines*.

## HardCopy IV Power Optimization

Because HardCopy IV devices have lower power requirements than Stratix IV devices, HardCopy IV devices do not need programmable power technology. The Quartus® II software compiles your HardCopy IV design according to the timing requirements specified in the timing constraint file. Due to smaller device geometry and optimized device architecture, HardCopy IV devices generally achieve faster performance and consume less power than Stratix IV devices.

 You can use the [PowerPlay Early Power Estimators](#) to determine the power requirements of your HardCopy IV device.

## Temperature Sensing Diode (TSD)

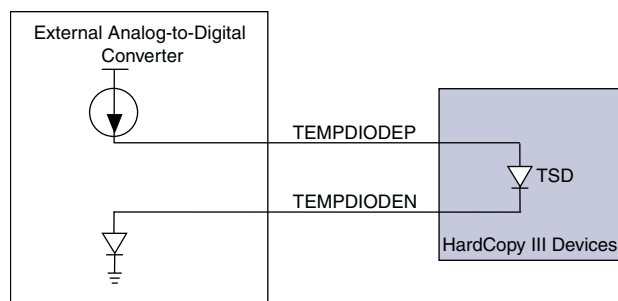
The HardCopy IV TSD uses the characteristics of a PN junction diode to determine die temperature. Knowing the junction temperature is crucial for thermal management. Junction temperature is calculated using ambient or case temperature, junction-to-ambient ( $\theta_{JA}$ ) or junction-to-case ( $\theta_{JC}$ ) thermal resistance, and the device power consumption.

To monitor the HardCopy IV die temperature, use the device's TSD with either external or embedded analog-to-digital converter (ADC) in the device. This allows you to control the air flow to the device. The ADC steers bias current through the HardCopy IV TSD, measuring forward voltage and converting this reading to temperature in the form of an 8-bit signed number (7 bits plus sign). The 8-bit output represents the junction temperature of the HardCopy IV device and can be used for intelligent power management.

## External Pin Connections

The HardCopy IV TSD, located in the top-right corner of the die, requires two pins for voltage reference. You can connect the TSD with an external ADC device, as shown in [Figure 11-1](#).

**Figure 11-1. TSD External Pin Connections in HardCopy IV Devices**



The TSD is a very sensitive circuit that can be influenced by noise coupled from other traces on the board and possibly within the device package itself, depending on device usage. The interfacing device registers temperature based on millivolts (mV) of difference, as seen at the TSD. Switching I/O near the TSD pins can affect the temperature reading. Altera recommends taking temperature readings during periods of no activity in the device. If the TSD is not connected to an external temperature sense device, then connect the TSD pins to GND.

## Document Revision History

Table 11-4 lists the revision history for this chapter.

**Table 11-4. Document Revision History**

Date	Version	Changes
January 2011	1.2	<ul style="list-style-type: none"> <li>■ Changed chapter title.</li> <li>■ Updated page 1.</li> <li>■ Updated the “Supporting HardCopy IV and Stratix IV Power Supplies”, “HardCopy IV Power Optimization”, “HardCopy IV Power Optimization”, “Temperature Sensing Diode (TSD)”, and “External Pin Connections” sections.</li> <li>■ Updated Table 11-2.</li> <li>■ Removed Figure 11-2 and 11-3.</li> <li>■ Minor text edits.</li> </ul>
January 2010	1.1	<ul style="list-style-type: none"> <li>■ Updated Table 11-2.</li> <li>■ Updated Figure 11-2 and Figure 11-3.</li> <li>■ Removed Figure 1-4 “HardCopy IV GX Power Management Example.”</li> <li>■ Minor text edits.</li> </ul>
June 2009	1.0	Initial release.

