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Embedded - System On Chip (SoC): The Heart of Modern Embedded Systems

Embedded - System On Chip (SoC) refers to an integrated circuit that consolidates all the essential components of a computer system into a single chip. This includes a microprocessor, memory, and other peripherals, all packed into one compact and efficient package. SoCs are designed to provide a complete computing solution, optimizing both space and power consumption, making them ideal for a wide range of embedded applications.

What are Embedded - System On Chip (SoC)?

System On Chip (SoC) integrates multiple functions of a computer or electronic system onto a single chip. Unlike traditional multi-chip solutions, SoCs combine a central

Details	
Product Status	Obsolete
Architecture	MCU, FPGA
Core Processor	Dual ARM® Cortex®-A9 MPCore™ with CoreSight™
Flash Size	-
RAM Size	64KB
Peripherals	DMA, POR, WDT
Connectivity	EBI/EMI, Ethernet, I²C, MMC/SD/SDIO, SPI, UART/USART, USB OTG
Speed	1.05GHz
Primary Attributes	FPGA - 462K Logic Elements
Operating Temperature	-40°C ~ 100°C (TJ)
Package / Case	1517-BBGA, FCBGA
Supplier Device Package	1517-FBGA, FC (40x40)
Purchase URL	https://www.e-xfl.com/product-detail/intel/5asxfb5h4f40i3nes

Caution: Conditions outside the range listed in the following table may cause permanent damage tothe device. Additionally, device operation at the absolute maximum ratings for extended periods of time may have adverse effects on the device.

Table 1-1: Absolute Maximum Ratings for Arria V Devices

Symbol	Description	Minimum	Maximum	Unit
V_{CC}	Core voltage power supply	–0.50	1.43	V
V_{CCP}	Periphery circuitry, PCIe® hardIP block, and transceiver physical coding sublayer (PCS) power supply	–0.50	1.43	V
V_{CCPGM}	Configuration pins power supply	–0.50	3.90	V
V_{CC_AUX}	Auxiliary supply	–0.50	3.25	V
V_{CCBAT}	Battery back-up power supply for design security volatile key register	–0.50	3.90	V
V_{CCPD}	I/O pre-driver power supply	–0.50	3.90	V
V_{CCIO}	I/O power supply	–0.50	3.90	V
V_{CCD_FPLL}	Phase-locked loop (PLL) digital power supply	–0.50	1.80	V
V_{CCA_FPLL}	PLL analog power supply	–0.50	3.25	V
V_{CCA_GXB}	Transceiver high voltage power	–0.50	3.25	V
V_{CCH_GXB}	Transmitter output buffer power	–0.50	1.80	V
V_{CCR_GXB}	Receiver power	–0.50	1.50	V
V_{CCT_GXB}	Transmitter power	–0.50	1.50	V
V_{CCL_GXB}	Transceiver clock network power	–0.50	1.50	V
V_I	DC input voltage	–0.50	3.80	V
V_{CC_HPS}	HPS core voltage and periphery circuitry power supply	–0.50	1.43	V
V_{CCPD_HPS}	HPS I/O pre-driver power supply	–0.50	3.90	V
V_{CCIO_HPS}	HPS I/O power supply	–0.50	3.90	V
$V_{CCRSTCLK\_HPS}$	HPS reset and clock input pins power supply	–0.50	3.90	V

Symbol	Description	Condition	Minimum[7]	Typical	Maximum[7]	Unit
$V_{CC\_AUX\_SHARED}$	HPS auxiliary power supply	—	2.375	2.5	2.625	V

Related Information

Recommended Operating Conditions on page 1-4
Provides the steady-state voltage values for the FPGA portion of the device.

DC Characteristics

Supply Current and Power Consumption

Altera offers two ways to estimate power for your design—the Excel-based Early Power Estimator (EPE) and the Quartus® Prime PowerPlay Power Analyzer feature.

Use the Excel-based EPE before you start your design to estimate the supply current for your design. The EPE provides a magnitude estimate of the device power because these currents vary greatly with the resources you use.

The Quartus Prime PowerPlay Power Analyzer provides better quality estimates based on the specifics of the design after you complete place-and-route. The PowerPlay Power Analyzer can apply a combination of user-entered, simulation-derived, and estimated signal activities that, when combined with detailed circuit models, yields very accurate power estimates.

Related Information

- **PowerPlay Early Power Estimator User Guide**
  Provides more information about power estimation tools.
- **PowerPlay Power Analysis chapter, Quartus Prime Handbook**
  Provides more information about power estimation tools.

[7] The power supply value describes the budget for the DC (static) power supply tolerance and does not include the dynamic tolerance requirements. Refer to the PDN tool for the additional budget for the dynamic tolerance requirements.

Transceiver Specifications for Arria V GT and ST Devices

Table 1-26: Reference Clock Specifications for Arria V GT and ST Devices

Symbol/Description	Condition	Transceiver Speed Grade 3			Unit
		Min	Typ	Max	
Supported I/O standards	1.2 V PCML, 1.4 VPCML, 1.5 V PCML, 2.5 V PCML, Differential LVPECL(40), HCSL, and LVDS				
Input frequency from REFCLK input pins	—	27	—	710	MHz
Rise time	Measure at ±60 mV of differential signal(41)	—	—	400	ps
Fall time	Measure at ±60 mV of differential signal(41)	—	—	400	ps
Duty cycle	—	45	—	55	%
Peak-to-peak differential input voltage	—	200	—	300(42)/2000	mV
Spread-spectrum modulating clock frequency	PCI Express (PCIe)	30	—	33	kHz
Spread-spectrum downspread	PCIe	—	0 to –0.5%	—	—
On-chip termination resistors	—	—	100	—	Ω
V_{ICM} (AC coupled)	—	—	1.2	—	V
V_{ICM} (DC coupled)	HCSL I/O standard for the PCIe reference clock	250	—	550	mV

(40) Differential LVPECL signal levels must comply to the minimum and maximum peak-to-peak differential input voltage specified in this table.
(41) REFCLK performance requires to meet transmitter REFCLK phase noise specification.
(42) The maximum peak-to peak differential input voltage of 300 mV is allowed for DC coupled link.

For example, when V_{OD} = 800 mV, the corresponding V_{OD} value setting is 40. The following conditions show that the 1st post tap pre-emphasis setting = 2 is valid:

- $|B| + |C| \leq 60 \rightarrow 40 + 2 = 42$
- $|B| - |C| > 5 \rightarrow 40 - 2 = 38$
- $(V_{MAX}/V_{MIN} - 1)\% < 600\% \rightarrow (42/38 - 1)\% = 10.52\%$

To predict the pre-emphasis level for your specific data rate and pattern, run simulations using the Arria V HSSI HSPICE models.

Table 1-33: Transmitter Pre-Emphasis Levels for Arria V Devices

Quartus Prime 1st Post Tap Pre-Emphasis Setting	Quartus Prime V_{OD} Setting							Unit
	10 (200 mV)	20 (400 mV)	30 (600 mV)	35 (700 mV)	40 (800 mV)	45 (900 mV)	50 (1000 mV)	
0	0	0	0	0	0	0	0	dB
1	1.97	0.88	0.43	0.32	0.24	0.19	0.13	dB
2	3.58	1.67	0.95	0.76	0.61	0.5	0.41	dB
3	5.35	2.48	1.49	1.2	1	0.83	0.69	dB
4	7.27	3.31	2	1.63	1.36	1.14	0.96	dB
5	—	4.19	2.55	2.1	1.76	1.49	1.26	dB
6	—	5.08	3.11	2.56	2.17	1.83	1.56	dB
7	—	5.99	3.71	3.06	2.58	2.18	1.87	dB
8	—	6.92	4.22	3.47	2.93	2.48	2.11	dB
9	—	7.92	4.86	4	3.38	2.87	2.46	dB
10	—	9.04	5.46	4.51	3.79	3.23	2.77	dB
11	—	10.2	6.09	5.01	4.23	3.61	—	dB
12	—	11.56	6.74	5.51	4.68	3.97	—	dB
13	—	12.9	7.44	6.1	5.12	4.36	—	dB
14	—	14.44	8.12	6.64	5.57	4.76	—	dB
15	—	—	8.87	7.21	6.06	5.14	—	dB

Protocol	Sub-protocol	Data Rate (Mbps)
Common Public Radio Interface (CPRI)	CPRI E6LV	614.4
	CPRI E6HV	614.4
	CPRI E6LVII	614.4
	CPRI E12LV	1,228.8
	CPRI E12HV	1,228.8
	CPRI E12LVII	1,228.8
	CPRI E24LV	2,457.6
	CPRI E24LVII	2,457.6
	CPRI E30LV	3,072
	CPRI E30LVII	3,072
	CPRI E48LVII	4,915.2
	CPRI E60LVII	6,144
	CPRI E96LVIII(60)	9,830.4
Gbps Ethernet (GbE)	GbE 1250	1,250
OBSAI	OBSAI 768	768
	OBSAI 1536	1,536
	OBSAI 3072	3,072
	OBSAI 6144	6,144
Serial digital interface (SDI)	SDI 270 SD	270
	SDI 1485 HD	1,485
	SDI 2970 3G	2,970

(60) You can achieve compliance with TX channel restriction of one HSSI channel per six-channel transceiver bank.

Symbol	Parameter	Condition	Min	Typ	Max	Unit
t_{OUTPJ_DC}[67]	Period jitter for dedicated clock output in integer PLL	$F_{OUT} \geq 100$ MHz	—	—	175	ps (p-p)
		$F_{OUT} < 100$ MHz	—	—	17.5	mUI (p-p)
t_{FOUTPJ_DC}[67]	Period jitter for dedicated clock output in fractional PLL	$F_{OUT} \geq 100$ MHz	—	—	250[68], 175[69]	ps (p-p)
		$F_{OUT} < 100$ MHz	—	—	25[68], 17.5[69]	mUI (p-p)
t_{OUTCCJ_DC}[67]	Cycle-to-cycle jitter for dedicated clock output in integer PLL	$F_{OUT} \geq 100$ MHz	—	—	175	ps (p-p)
		$F_{OUT} < 100$ MHz	—	—	17.5	mUI (p-p)
$t_{FOUTCCJ\_DC}$[67]	Cycle-to-cycle jitter for dedicated clock output in fractional PLL	$F_{OUT} \geq 100$ MHz	—	—	250[68], 175[69]	ps (p-p)
		$F_{OUT} < 100$ MHz	—	—	25[68], 17.5[69]	mUI (p-p)
t_{OUTPJ_IO}[67][70]	Period jitter for clock output on a regular I/O in integer PLL	$F_{OUT} \geq 100$ MHz	—	—	600	ps (p-p)
		$F_{OUT} < 100$ MHz	—	—	60	mUI (p-p)
t_{FOUTPJ_IO}[67][68][70]	Period jitter for clock output on a regular I/O in fractional PLL	$F_{OUT} \geq 100$ MHz	—	—	600	ps (p-p)
		$F_{OUT} < 100$ MHz	—	—	60	mUI (p-p)
t_{OUTCCJ_IO}[67][70]	Cycle-to-cycle jitter for clock output on a regular I/O in integer PLL	$F_{OUT} \geq 100$ MHz	—	—	600	ps (p-p)
		$F_{OUT} < 100$ MHz	—	—	60	mUI (p-p)
$t_{FOUTCCJ\_IO}$[67][68][70]	Cycle-to-cycle jitter for clock output on a regular I/O in fractional PLL	$F_{OUT} \geq 100$ MHz	—	—	600	ps (p-p)
		$F_{OUT} < 100$ MHz	—	—	60	mUI (p-p)

(67) Peak-to-peak jitter with a probability level of 10^{-12} (14 sigma, 99.99999999974404% confidence level). The output jitter specification applies to the intrinsic jitter of the PLL, when an input jitter of 30 ps is applied. The external memory interface clock output jitter specifications use a different measurement method and are available in Memory Output Clock Jitter Specification for Arria V Devices table.

(68) This specification only covered fractional PLL for low bandwidth. The f_{VCO} for fractional value range 0.05–0.95 must be ≥ 1000 MHz.

(69) This specification only covered fractional PLL for low bandwidth. The f_{VCO} for fractional value range 0.20–0.80 must be ≥ 1200 MHz.

(70) External memory interface clock output jitter specifications use a different measurement method, which are available in Memory Output Clock Jitter Specification for Arria V Devices table.

Table 1-38: Memory Block Performance Specifications for Arria V Devices

Memory	Mode	Resources Used		Performance			Unit
		ALUTs	Memory	–I3, –C4	–I5, –C5	–C6	
MLAB	Single port, all supported widths	0	1	500	450	400	MHz
	Simple dual-port, all supported widths	0	1	500	450	400	MHz
	Simple dual-port with read and write at the same address	0	1	400	350	300	MHz
	ROM, all supported width	—	—	500	450	400	MHz
M10K Block	Single-port, all supported widths	0	1	400	350	285	MHz
	Simple dual-port, all supported widths	0	1	400	350	285	MHz
	Simple dual-port with the read-during-write option set to **Old Data**, all supported widths	0	1	315	275	240	MHz
	True dual port, all supported widths	0	1	400	350	285	MHz
	ROM, all supported widths	0	1	400	350	285	MHz

Internal Temperature Sensing Diode Specifications

Table 1-39: Internal Temperature Sensing Diode Specifications for Arria V Devices

Temperature Range	Accuracy	Offset Calibrated Option	Sampling Rate	Conversion Time	Resolution	Minimum Resolution with no Missing Codes
–40 to 100°C	±8°C	No	1 MHz	< 100 ms	8 bits	8 bits

Periphery Performance

This section describes the periphery performance, high-speed I/O, and external memory interface.

Actual achievable frequency depends on design and system specific factors. Ensure proper timing closure in your design and perform HSPICE/IBIS simulations based on your specific design and system setup to determine the maximum achievable frequency in your system.

Symbol		Condition	–I3, –C4			–I5, –C5			–C6			Unit
			Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
	TCCS	True Differential I/O Standards	—	—	150	—	—	150	—	—	150	ps
		Emulated Differential I/O Standards	—	—	300	—	—	300	—	—	300	ps
Receiver	True Differential I/O Standards - $f_{HSDRDPA}$ (data rate)	SERDES factor J =3 to 10(76)	150	—	1250	150	—	1250	150	—	1050	Mbps
		SERDES factor J ≥ 8 with DPA(76)(78)	150	—	1600	150	—	1500	150	—	1250	Mbps
	f_{HSDR} (data rate)	SERDES factor J = 3 to 10	(77)	—	(83)	(77)	—	(83)	(77)	—	(83)	Mbps
		SERDES factor J = 1 to 2, uses DDR registers	(77)	—	(79)	(77)	—	(79)	(77)	—	(79)	Mbps
DPA Mode	DPA run length	—	—	—	10000	—	—	10000	—	—	10000	UI
Soft-CDR Mode	Soft-CDR ppm tolerance	—	—	—	300	—	—	300	—	—	300	±ppm
Non-DPA Mode	Sampling Window	—	—	—	300	—	—	300	—	—	300	ps

(83) You can estimate the achievable maximum data rate for non-DPA mode by performing link timing closure analysis. You must consider the board skew margin, transmitter delay margin, and receiver sampling margin to determine the maximum data rate supported.

HPS PLL Input Jitter

Use the following equation to determine the maximum input jitter (peak-to-peak) the HPS PLLs can tolerate. The divide value (N) is the value programmed into the denominator field of the VCO register for each PLL. The PLL input reference clock is divided by this value. The range of the denominator is 1 to 64.

Maximum input jitter = Input clock period × Divide value (N) × 0.02

Table 1-50: Examples of Maximum Input Jitter

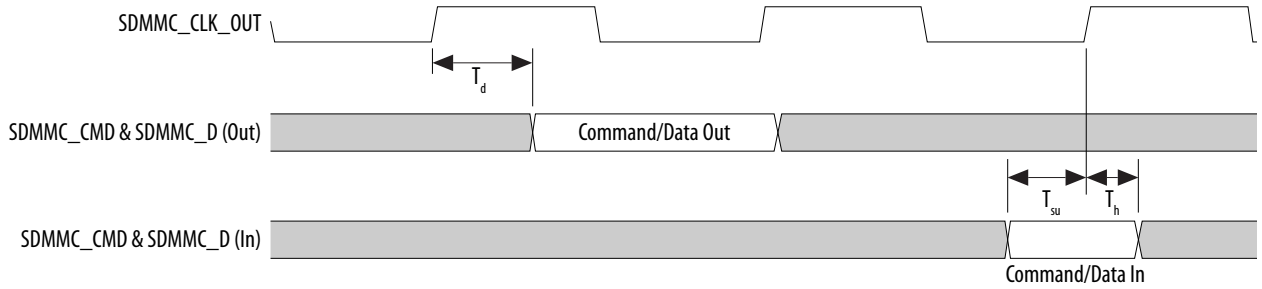
Input Reference Clock Period	Divide Value (N)	Maximum Jitter	Unit
40 ns	1	0.8	ns
40 ns	2	1.6	ns
40 ns	4	3.2	ns

Quad SPI Flash Timing Characteristics

Table 1-51: Quad Serial Peripheral Interface (SPI) Flash Timing Requirements for Arria V Devices

Symbol	Description	Min	Typ	Max	Unit
F_{clk}	SCLK_OUT clock frequency (External clock)	—	—	108	MHz
T_{qspi_clk}	QSPI_CLK clock period (Internal reference clock)	2.32	—	—	ns
$T_{dutycycle}$	SCLK_OUT duty cycle	45	—	55	%
$T_{dssfrst}$	Output delay QSPI_SS valid before first clock edge	—	1/2 cycle of SCLK_OUT	—	ns
T_{dsslst}	Output delay QSPI_SS valid after last clock edge	–1	—	1	ns
T_{dio}	I/O data output delay	–1	—	1	ns
T_{din_start}	Input data valid start	—	—	$(2 + R_{delay}) \times T_{qspi\_clk} - 7.52$ (85)	ns

Figure 1-11: SD/MMC Timing Diagram



Related Information

Booting and Configuration Chapter, Arria V Hard Processor System Technical Reference Manual
Provides more information about CSEL pin settings in the SD/MMC Controller CSEL Pin Settings table.

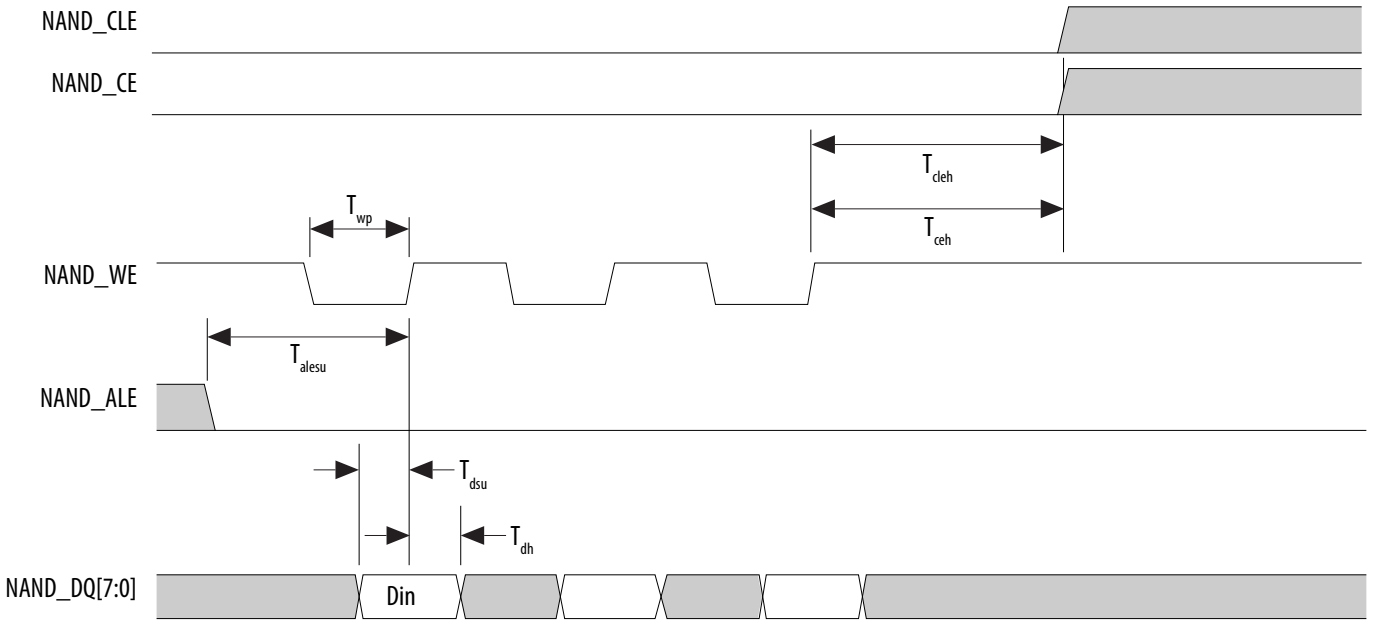
USB Timing Characteristics

PHYs that support LPM mode may not function properly with the USB controller due to a timing issue. It is recommended that designers use the MicroChip USB3300 PHY device that has been proven to be successful on the development board.

Table 1-55: USB Timing Requirements for Arria V Devices

Symbol	Description	Min	Typ	Max	Unit
T_{clk}	USB CLK clock period	—	16.67	—	ns
T_d	CLK to USB_STP/USB_DATA[7:0] output delay	4.4	—	11	ns
T_{su}	Setup time for USB_DIR/USB_NXT/USB_DATA[7:0]	2	—	—	ns
T_h	Hold time for USB_DIR/USB_NXT/USB_DATA[7:0]	1	—	—	ns

Figure 1-19: NAND Data Write Timing Diagram



I/O Standard	$V_{IL(DC)}$ (V)		$V_{IH(DC)}$ (V)		$V_{IL(AC)}$ (V)	$V_{IH(AC)}$ (V)	V_{OL} (V)	V_{OH} (V)	I_{ol} (mA)	I_{oh} (mA)
	Min	Max	Min	Max	Max	Min	Max	Min		
SSTL-18 Class II	–0.3	V_{REF} – 0.125	V_{REF} + 0.125	V_{CCIO} + 0.3	V_{REF} – 0.25	V_{REF} + 0.25	0.28	V_{CCIO} – 0.28	13.4	–13.4
SSTL-15 Class I	—	V_{REF} – 0.1	V_{REF} + 0.1	—	V_{REF} – 0.175	V_{REF} + 0.175	0.2 × V_{CCIO}	0.8 × V_{CCIO}	8	–8
SSTL-15 Class II	—	V_{REF} – 0.1	V_{REF} + 0.1	—	V_{REF} – 0.175	V_{REF} + 0.175	0.2 × V_{CCIO}	0.8 × V_{CCIO}	16	–16
SSTL-135 Class I, II	—	V_{REF} – 0.09	V_{REF} + 0.09	—	V_{REF} – 0.16	V_{REF} + 0.16	0.2 * V_{CCIO}	0.8 * V_{CCIO}	—	—
SSTL-125 Class I, II	—	V_{REF} – 0.85	V_{REF} + 0.85	—	V_{REF} – 0.15	V_{REF} + 0.15	0.2 * V_{CCIO}	0.8 * V_{CCIO}	—	—
SSTL-12 Class I, II	—	V_{REF} – 0.1	V_{REF} + 0.1	—	V_{REF} – 0.15	V_{REF} + 0.15	0.2 * V_{CCIO}	0.8 * V_{CCIO}	—	—
HSTL-18 Class I	—	V_{REF} – 0.1	V_{REF} + 0.1	—	V_{REF} – 0.2	V_{REF} + 0.2	0.4	V_{CCIO} – 0.4	8	–8
HSTL-18 Class II	—	V_{REF} – 0.1	V_{REF} + 0.1	—	V_{REF} – 0.2	V_{REF} + 0.2	0.4	V_{CCIO} – 0.4	16	–16
HSTL-15 Class I	—	V_{REF} – 0.1	V_{REF} + 0.1	—	V_{REF} – 0.2	V_{REF} + 0.2	0.4	V_{CCIO} – 0.4	8	–8
HSTL-15 Class II	—	V_{REF} – 0.1	V_{REF} + 0.1	—	V_{REF} – 0.2	V_{REF} + 0.2	0.4	V_{CCIO} – 0.4	16	–16
HSTL-12 Class I	–0.15	V_{REF} – 0.08	V_{REF} + 0.08	V_{CCIO} + 0.15	V_{REF} – 0.15	V_{REF} + 0.15	0.25 × V_{CCIO}	0.75 × V_{CCIO}	8	–8
HSTL-12 Class II	–0.15	V_{REF} – 0.08	V_{REF} + 0.08	V_{CCIO} + 0.15	V_{REF} – 0.15	V_{REF} + 0.15	0.25 × V_{CCIO}	0.75 × V_{CCIO}	16	–16
HSUL-12	—	V_{REF} – 0.13	V_{REF} + 0.13	—	V_{REF} – 0.22	V_{REF} + 0.22	0.1 × V_{CCIO}	0.9 × V_{CCIO}	—	—

Table 2-19: Differential SSTL I/O Standards for Arria V GZ Devices

I/O Standard	V_{CCIO} (V)			$V_{SWING(DC)}$ (V)		$V_{X(AC)}$ (V)			$V_{SWING(AC)}$ (V)	
	Min	Typ	Max	Min	Max	Min	Typ	Max	Min	Max
SSTL-2 Class I, II	2.375	2.5	2.625	0.3	V_{CCIO} + 0.6	$V_{CCIO}/2$ – 0.2	—	$V_{CCIO}/2$ + 0.2	0.62	V_{CCIO} + 0.6
SSTL-18 Class I, II	1.71	1.8	1.89	0.25	V_{CCIO} + 0.6	$V_{CCIO}/2$ – 0.175	—	$V_{CCIO}/2$ + 0.175	0.5	V_{CCIO} + 0.6
SSTL-15 Class I, II	1.425	1.5	1.575	0.2	(127)	$V_{CCIO}/2$ – 0.15	—	$V_{CCIO}/2$ + 0.15	0.35	—
SSTL-135 Class I, II	1.283	1.35	1.45	0.2	(127)	$V_{CCIO}/2$ – 0.15	$V_{CCIO}/2$	$V_{CCIO}/2$ + 0.15	$2(V_{IH(AC)} - V_{REF})$	$2(V_{IL(AC)} - V_{REF})$
SSTL-125 Class I, II	1.19	1.25	1.31	0.18	(127)	$V_{CCIO}/2$ – 0.15	$V_{CCIO}/2$	$V_{CCIO}/2$ + 0.15	$2(V_{IH(AC)} - V_{REF})$	—
SSTL-12 Class I, II	1.14	1.2	1.26	0.18	—	V_{REF} –0.15	$V_{CCIO}/2$	V_{REF} + 0.15	–0.30	0.30

Table 2-20: Differential HSTL and HSUL I/O Standards for Arria V GZ Devices

I/O Standard	V_{CCIO} (V)			$V_{DIF(DC)}$ (V)		$V_{X(AC)}$ (V)			$V_{CM(DC)}$ (V)			$V_{DIF(AC)}$ (V)	
	Min	Typ	Max	Min	Max	Min	Typ	Max	Min	Typ	Max	Min	Max
HSTL-18 Class I, II	1.71	1.8	1.89	0.2	—	0.78	—	1.12	0.78	—	1.12	0.4	—
HSTL-15 Class I, II	1.425	1.5	1.575	0.2	—	0.68	—	0.9	0.68	—	0.9	0.4	—

(127) The maximum value for $V_{SWING(DC)}$ is not defined. However, each single-ended signal needs to be within the respective single-ended limits ($V_{IH(DC)}$ and $V_{IL(DC)}$).

Symbol/Description	Conditions	Transceiver Speed Grade 2			Transceiver Speed Grade 3			Unit
		Min	Typ	Max	Min	Typ	Max	
`fixedclk` clock frequency	PCIe Receiver Detect	—	100 or 125	—	—	100 or 125	—	MHz
Reconfiguration clock (`mgmt_clk_clk`) frequency	—	100	—	125	100	—	125	MHz

Related Information

Arria V Device Overview

For more information about device ordering codes.

Receiver

Table 2-24: Receiver Specifications for Arria V GZ Devices

Speed grades shown refer to the PMA Speed Grade in the device ordering code. The maximum data rate could be restricted by the Core/PCS speed grade. Contact your Altera Sales Representative for the maximum data rate specifications in each speed grade combination offered. For more information about device ordering codes, refer to the *Arria V Device Overview*.

Symbol/Description	Conditions	Transceiver Speed Grade 2			Transceiver Speed Grade 3			Unit
		Min	Typ	Max	Min	Typ	Max	
Supported I/O Standards	1.4-V PCML, 1.5-V PCML, 2.5-V PCML, LVPECL, and LVDS							
Data rate (Standard PCS) (143), (144)	—	600	—	9900	600	—	8800	Mbps
Data rate (10G PCS) (143), (144)	—	600	—	12500	600	—	10312.5	Mbps
Absolute V_{MAX} for a receiver pin (145)	—	—	—	1.2	—	—	1.2	V
Absolute V_{MIN} for a receiver pin	—	–0.4	—	—	–0.4	—	—	V

(143) The line data rate may be limited by PCS-FPGA interface speed grade.
(144) To support data rates lower than the minimum specification through oversampling, use the CDR in LTR mode only.
(145) The device cannot tolerate prolonged operation at this absolute maximum.

Core Performance Specifications

Clock Tree Specifications

Table 2-33: Clock Tree Performance for Arria V GZ Devices

Symbol	Performance		Unit
	C3, I3L	C4, I4	
Global and Regional Clock	650	580	MHz
Periphery Clock	500	500	MHz

PLL Specifications

Table 2-34: PLL Specifications for Arria V GZ Devices

Symbol	Parameter	Min	Typ	Max	Unit
f_{IN} (167)	Input clock frequency (C3, I3L speed grade)	5	—	800	MHz
	Input clock frequency (C4, I4 speed grade)	5	—	650	MHz
f_{INPFD}	Input frequency to the PFD	5	—	325	MHz
f_{FINPFD}	Fractional Input clock frequency to the PFD	50	—	160	MHz
f_{VCO} (168)	PLL VCO operating range (C3, I3L speed grade)	600	—	1600	MHz
	PLL VCO operating range (C4, I4 speed grade)	600	—	1300	MHz
$t_{EINDUTY}$	Input clock or external feedback clock input duty cycle	40	—	60	%

(167) This specification is limited in the Quartus II software by the I/O maximum frequency. The maximum I/O frequency is different for each I/O standard.

(168) The VCO frequency reported by the Quartus II software in the **PLL Usage Summary** section of the compilation report takes into consideration the VCO post-scale counter K value. Therefore, if the counter K has a value of 2, the frequency reported can be lower than the f_{VCO} specification.

Table 2-62: Uncompressed .rbf Sizes for Arria V GZ Devices

Variant	Member Code	Configuration .rbf Size (bits)	IOCSR .rbf Size (bits) (223)
Arria V GZ	E1	137,598,880	562,208
	E3	137,598,880	562,208
	E5	213,798,880	561,760
	E7	213,798,880	561,760

Table 2-63: Minimum Configuration Time Estimation for Arria V GZ Devices

Variant	Member Code	Active Serial (224)			Fast Passive Parallel (225)		
		Width	DCLK (MHz)	Min Config Time (ms)	Width	DCLK (MHz)	Min Config Time (ms)
Arria V GZ	E1	4	100	344	32	100	43
	E3	4	100	344	32	100	43
	E5	4	100	534	32	100	67
	E7	4	100	534	32	100	67

Remote System Upgrades Circuitry Timing Specification

Table 2-64: Remote System Upgrade Circuitry Timing Specifications

Parameter	Minimum	Maximum	Unit
$t_{RU\_nCONFIG}$ (226)	250	—	ns
$t_{RU\_nRSTIMER}$ (227)	250	—	ns

(223) The IOCSR **.rbf** size is specifically for the Configuration via Protocol (CvP) feature.
(224) DCLK frequency of 100 MHz using external CLKUSR.
(225) Max FPGA FPP bandwidth may exceed bandwidth available from some external storage or control logic.

Programmable IOE Delay

Table 2-66: IOE Programmable Delay for Arria V GZ Devices

Parameter [228]	Available Settings	Min Offset [229]	Fast Model		Slow Model				Unit
			Industrial	Commercial	C3	C4	I3L	I4	
D1	64	0	0.464	0.493	0.924	1.011	0.921	1.006	ns
D2	32	0	0.230	0.244	0.459	0.503	0.456	0.500	ns
D3	8	0	1.587	1.699	2.992	3.192	3.047	3.257	ns
D4	64	0	0.464	0.492	0.924	1.011	0.920	1.006	ns
D5	64	0	0.464	0.493	0.924	1.011	0.921	1.006	ns
D6	32	0	0.229	0.244	0.458	0.503	0.456	0.499	ns

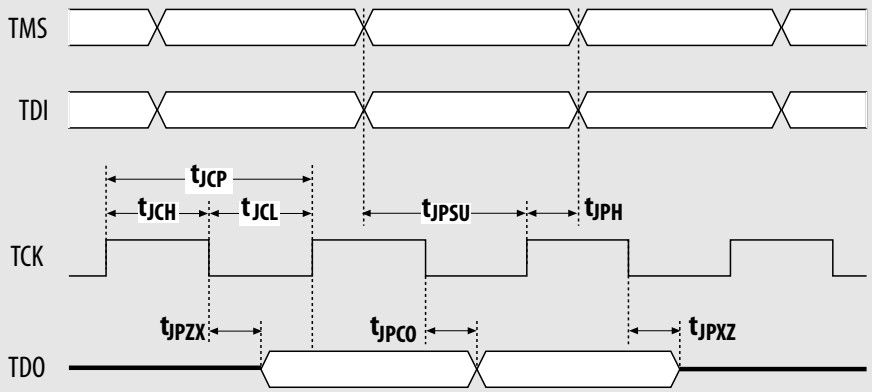
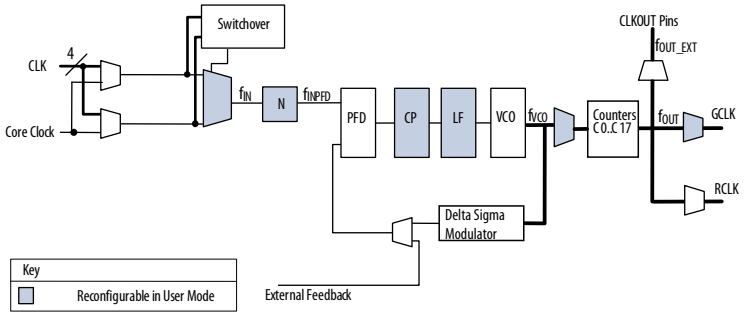
Programmable Output Buffer Delay

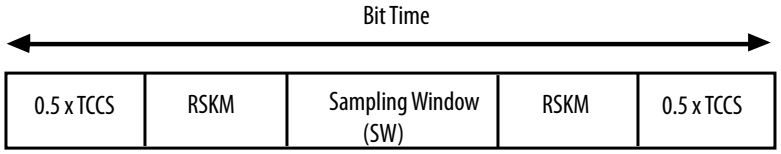
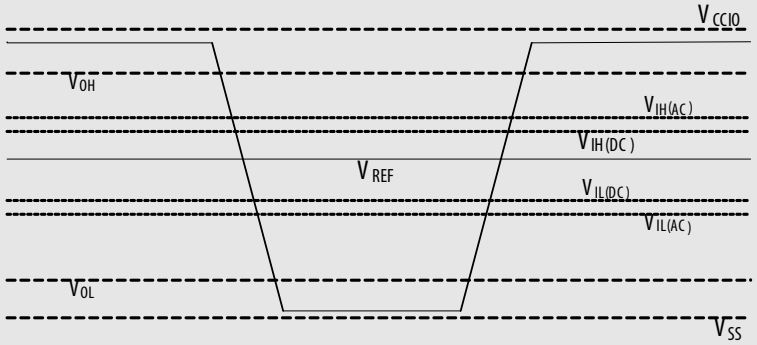
Table 2-67: Programmable Output Buffer Delay for Arria V GZ Devices

You can set the programmable output buffer delay in the Quartus II software by setting the **Output Buffer Delay Control** assignment to either positive, negative, or both edges, with the specific values stated here (in ps) for the **Output Buffer Delay** assignment.

Symbol	Parameter	Typical	Unit
D_{OUTBUF}	Rising and/or falling edge delay	0 (default)	ps
		50	ps
		100	ps
		150	ps

(228) You can set this value in the Quartus II software by selecting **D1**, **D2**, **D3**, **D4**, **D5**, and **D6** in the **Assignment Name** column of **Assignment Editor**.
(229) Minimum offset does not include the intrinsic delay.

Term	Definition
JTAG Timing Specifications	JTAG Timing Specifications: 
PLL Specifications	Diagram of PLL Specifications  Note: 1. Core Clock can only be fed by dedicated clock input pins or PLL outputs.

Term	Definition
R_L	Receiver differential input discrete resistor (external to the Arria V GZ device).
SW (sampling window)	Timing Diagram—the period of time during which the data must be valid in order to capture it correctly. The setup and hold times determine the ideal strobe position within the sampling window, as shown: 
Single-ended voltage referenced I/O standard	The JEDEC standard for SSTL and HSTL I/O defines both the AC and DC input signal values. The AC values indicate the voltage levels at which the receiver must meet its timing specifications. The DC values indicate the voltage levels at which the final logic state of the receiver is unambiguously defined. After the receiver input has crossed the AC value, the receiver changes to the new logic state. The new logic state is then maintained as long as the input stays beyond the DC threshold. This approach is intended to provide predictable receiver timing in the presence of input waveform ringing: Single-Ended Voltage Referenced I/O Standard 

Date	Version	Changes

June 2016	2016.06.20	• Changed column heading from "Value" to "Maximum" in the "Pin Capacitance for Arria V GZ Devices" table.
		• Changed the minimum supported data rate range values from "1000" to "2000" in the "ATX PLL Specifications for Arria V GZ Devices" table.
		• Added the supported data rates for the following output standards using true LVDS output buffer types in the "High-Speed Clock Specifications for Arria V GZ Devices" table:
		  • True RSDS output standard: data rates of up to 230 Mbps
		  • True mini-LVDS output standard: data rates of up to 340 Mbps

December 2015	2015.12.16	• Removed the CDR ppm tolerance specification from the "Receiver Specifications for Arria V GZ Devices" table. • Removed transmitter rise and fall time specifications from the "Transmitter Specifications for Arria V GZ Devices" table. • Changed the .rbf sizes in the "Uncompressed .rbf Sizes for Arria V GZ Devices" table. • Added a footnote to the "Transmitter High-Speed I/O Specifications for Arria V GZ Devices" table.
June 2015	2015.06.16	• Changed the conditions for the reference clock rise and fall time and added a note to the condition in the "Reference Clock Specifications for Arria V GZ Devices" table. • Added a note to the "Minimum differential eye opening at receiver serial input pins" specification in the "Receiver Specifications for Arria V GZ Devices" table.
January 2015	2015.01.30	• Added 240-Ω to the "OCT Calibration Accuracy Specifications for Arria V GZ Devices" table. • Changed the CDR PPM tolerance spec in the "Receiver Specifications for Arria V GZ Devices" table. • Added additional max data rate for fPLL in the "Fractional PLL Specifications for Arria V GZ Devices" table.