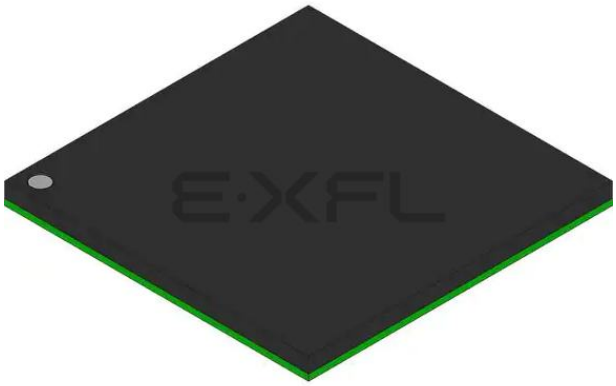
Altera - EP1AGX20CF484I6 Datasheet



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Understanding Embedded - FPGAs (Field Programmable Gate Array)

Embedded - FPGAs, or Field Programmable Gate Arrays, are advanced integrated circuits that offer unparalleled flexibility and performance for digital systems. Unlike traditional fixed-function logic devices, FPGAs can be programmed and reprogrammed to execute a wide array of logical operations, enabling customized functionality tailored to specific applications. This reprogrammability allows developers to iterate designs quickly and implement complex functions without the need for custom hardware.

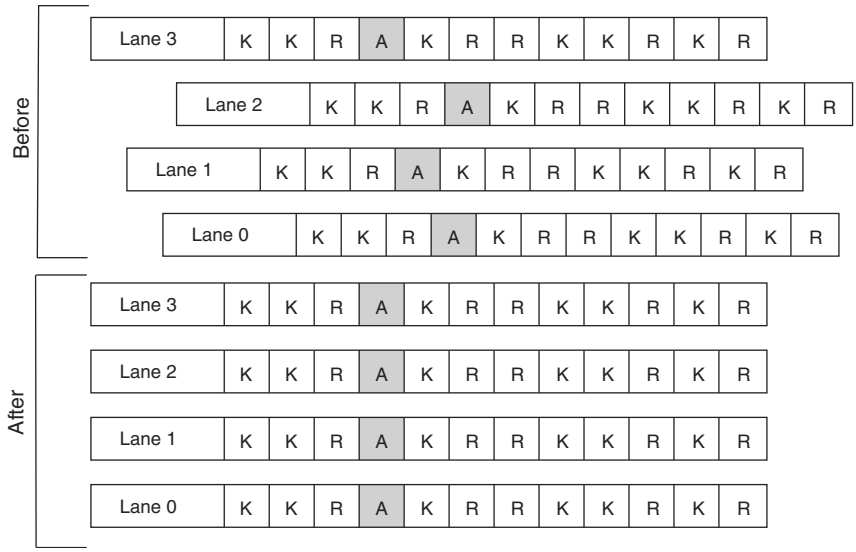
Applications of Embedded - FPGAs

The versatility of Embedded - FPGAs makes them indispensable in numerous fields. In telecommunications.

Details	
Product Status	Active
Number of LABs/CLBs	-
Number of Logic Elements/Cells	-
Total RAM Bits	-
Number of I/O	230
Number of Gates	-
Voltage - Supply	1.15V ~ 1.25V
Mounting Type	Surface Mount
Operating Temperature	-40°C ~ 100°C (TJ)
Package / Case	484-BBGA
Supplier Device Package	484-FBGA (23x23)
Purchase URL	https://www.e-xfl.com/pro/item?MUrl=&PartUrl=ep1agx20cf484i6

Figure 2–16 shows misaligned channels before the channel aligner and the aligned channels after the channel aligner.

Figure 2–16. Before and After the Channel Aligner



Rate Matcher

In asynchronous systems, the upstream transmitter and local receiver can be clocked with independent reference clock sources. Frequency differences in the order of a few hundred PPM can potentially corrupt the data at the receiver.

The rate matcher compensates for small clock frequency differences between the upstream transmitter and the local receiver clocks by inserting or removing skip characters from the inter packet gap (IPG) or idle streams. It inserts a skip character if the local receiver is running a faster clock than the upstream transmitter. It deletes a skip character if the local receiver is running a slower clock than the upstream transmitter. The Quartus II software automatically configures the appropriate skip character as specified in the IEEE 802.3 for GIGE mode and PCI-Express Base Specification for PCI Express (PIPE) mode. The rate matcher is bypassed in Serial RapidIO and must be implemented in the PLD logic array or external circuits depending on your system design.

Table 2–5 lists the maximum frequency difference that the rate matcher can tolerate in XAUI, PCI Express (PIPE), GIGE, and Basic functional modes.

Table 2–5. Rate Matcher PPM Tolerance

Function Mode	PPM
XAUI	± 100
PCI Express (PIPE)	± 300
GIGE	± 100
Basic	± 300

In GIGE and Serial RapidIO modes, you can dynamically put each transceiver channel individually in serial loopback by controlling the `rx_seriallpbken` port. A high on the `rx_seriallpbken` port puts the transceiver into serial loopback and a low takes the transceiver out of serial loopback.

As seen in Figure 2–18, the serial data output from the transmitter serializer is looped back to the receiver CRU in serial loopback. The transmitter data path from the PLD interface to the serializer in serial loopback is the same as in non-loopback mode. The receiver data path from the clock recovery unit to the PLD interface in serial loopback is the same as in non-loopback mode. Because the entire transceiver data path is available in serial loopback, this option is often used to diagnose the data path as a probable cause of link errors.

☞ When serial loopback is enabled, the transmitter output buffer is still active and drives the serial data out on the `tx_dataout` port.

Reverse Serial Loopback

Reverse serial loopback mode uses the analog portion of the transceiver. An external source (pattern generator or transceiver) generates the source data. The high-speed serial source data arrives at the high-speed differential receiver input buffer, passes through the CRU unit and the retimed serial data is looped back, and is transmitted though the high-speed differential transmitter output buffer.

Figure 2–19 shows the data path in reverse serial loopback mode.

Figure 2–19. Arria GX Block in Reverse Serial Loopback Mode

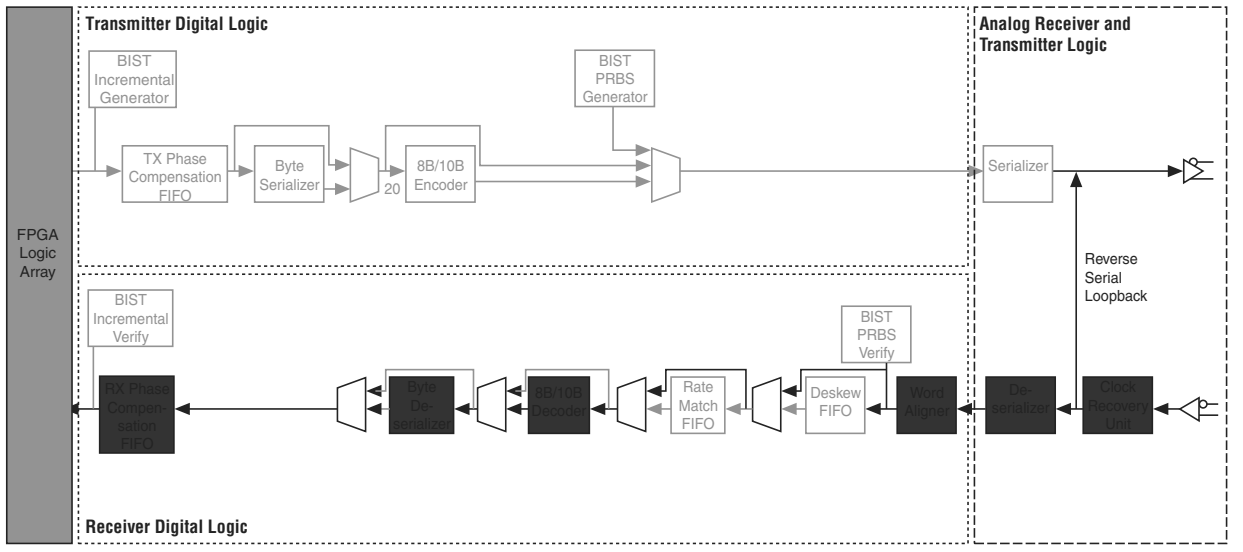
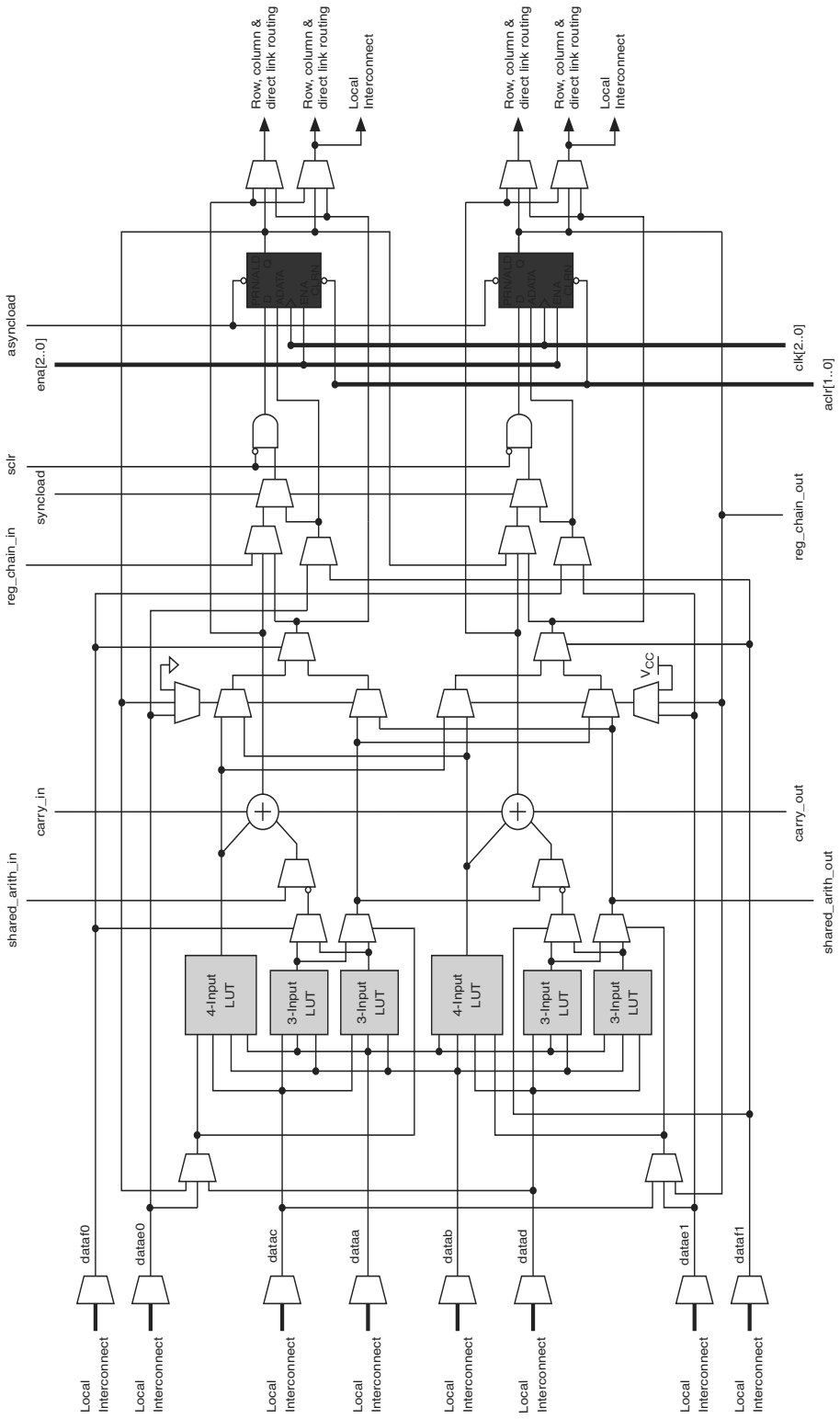


Figure 2–29. Arria GX ALM Details



Modes of Operation

The adder, subtractor, and accumulate functions of a DSP block have four modes of operation:

- Simple multiplier
- Multiply-accumulator
- Two-multipliers adder
- Four-multipliers adder

Table 2–14 shows the different number of multipliers possible in each DSP block mode according to size. These modes allow the DSP blocks to implement numerous applications for DSP including FFTs, complex FIR, FIR, 2D FIR filters, equalizers, IIR, correlators, matrix multiplication, and many other functions. DSP blocks also support mixed modes and mixed multiplier sizes in the same block. For example, half of one DSP block can implement one 18 × 18-bit multiplier in multiply-accumulator mode, while the other half of the DSP block implements four 9 × 9-bit multipliers in simple multiplier mode.

Table 2–14. Multiplier Size and Configurations per DSP Block

DSP Block Mode	9 × 9	18 × 18	36 × 36
Multiplier	Eight multipliers with eight product outputs	Four multipliers with four product outputs	One multiplier with one product output
Multiply-accumulator	—	Two 52-bit multiply-accumulate blocks	—
Two-multipliers adder	Four two-multiplier adder (two 9 × 9 complex multiply)	Two two-multiplier adder (one 18 × 18 complex multiply)	—
Four-multipliers adder	Two four-multiplier adder	One four-multiplier adder	—

DSP Block Interface

The Arria GX device DSP block input registers can generate a shift register that can cascade down in the same DSP block column. Dedicated connections between DSP blocks provide fast connections between shift register inputs to cascade shift register chains. You can cascade registers within multiple DSP blocks for 9 × 9- or 18 × 18-bit FIR filters larger than four taps, with additional adder stages implemented in ALMs. If the DSP block is configured as 36 × 36 bits, the adder, subtractor, or accumulator stages are implemented in ALMs. Each DSP block can route the shift register chain out of the block to cascade multiple columns of DSP blocks.

The DSP block is divided into four block units that interface with four LAB rows on the left and right. Each block unit can be considered one complete 18 × 18-bit multiplier with 36 inputs and 36 outputs. A local interconnect region is associated with each DSP block. Like an LAB, this interconnect region can be fed with 16 direct link interconnects from the LAB to the left or right of the DSP block in the same row. R4 and C4 routing resources can access the DSP block's local interconnect region.

The outputs also work similarly to LAB outputs. Eighteen outputs from the DSP block can drive to the left LAB through direct link interconnects and 18 can drive to the right LAB though direct link interconnects. All 36 outputs can drive to R4 and C4 routing interconnects. Outputs can drive right- or left-column routing.

Figure 2–52 and Figure 2–53 show the DSP block interfaces to LAB rows.

Figure 2–52. DSP Block Interconnect Interface

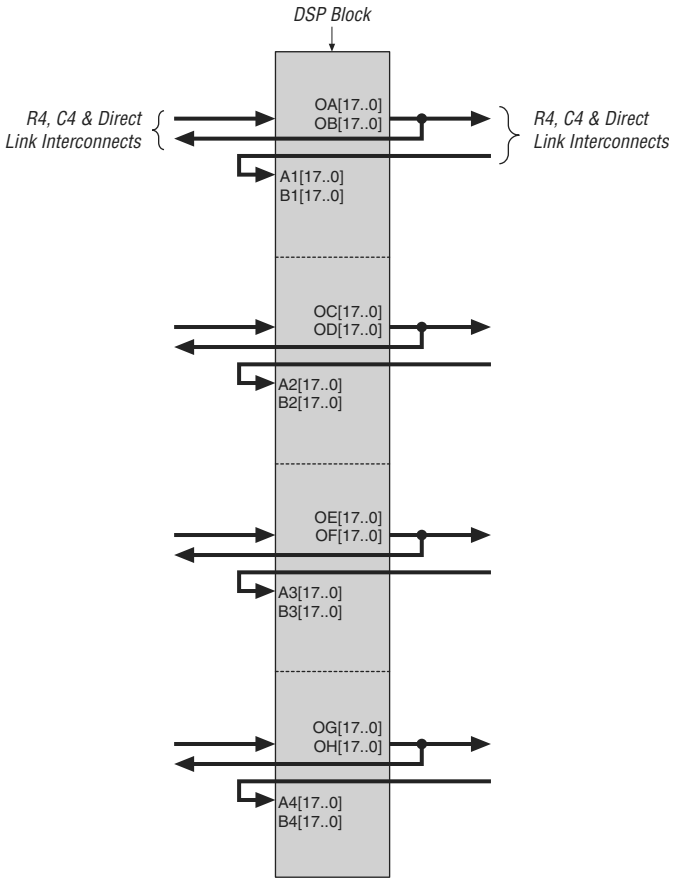
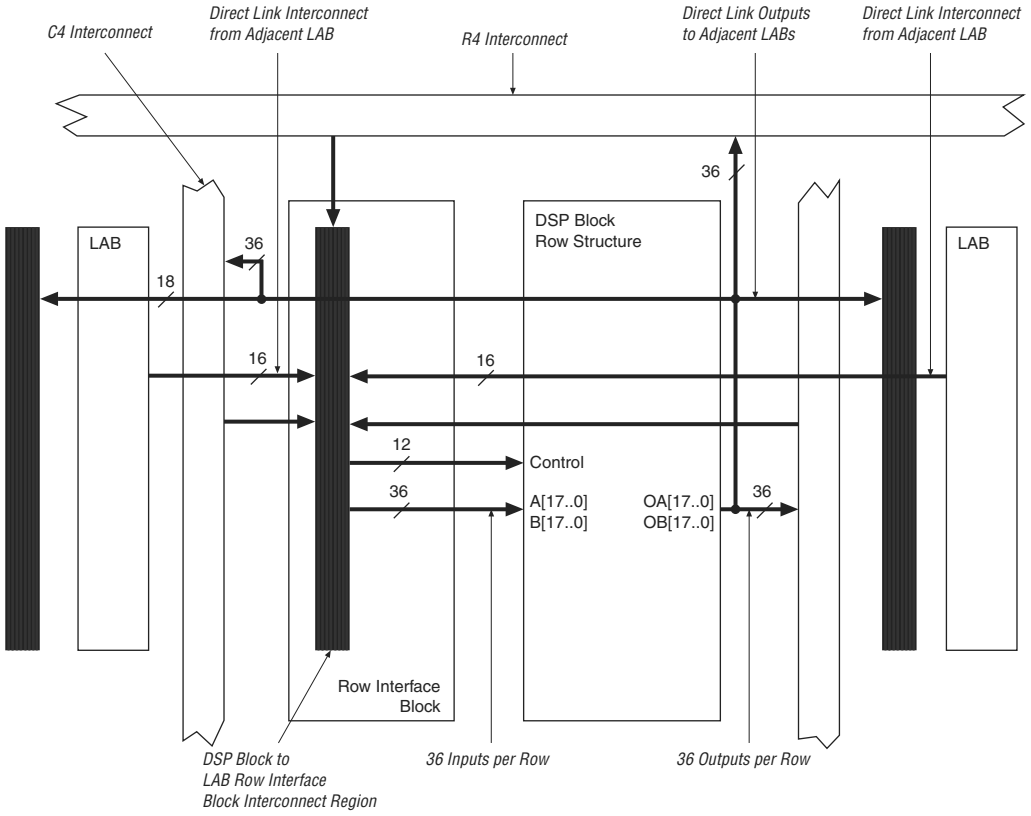


Figure 2–53. DSP Block Interface to Interconnect



A bus of 44 control signals feeds the entire DSP block. These signals include clocks, asynchronous clears, clock enables, signed and unsigned control signals, addition and subtraction control signals, rounding and saturation control signals, and accumulator synchronous loads. The clock signals are routed from LAB row clocks and are generated from specific LAB rows at the DSP block interface. The LAB row source for control signals, data inputs, and outputs is shown in Table 2–15.

For more information about DSP blocks, refer to the *DSP Blocks in Arria GX Devices* chapter.

Table 2–24 shows the possible settings for I/O standards with drive strength control.

Table 2–24. Programmable Drive Strength *(Note 1)*

I/O Standard	I_{OH} / I_{OL} Current Strength Setting (mA) for Column I/O Pins	I_{OH} / I_{OL} Current Strength Setting (mA) for Row I/O Pins
3.3-V LVTTL	24, 20, 16, 12, 8, 4	12, 8, 4
3.3-V LVCMOS	24, 20, 16, 12, 8, 4	8, 4
2.5-V LVTTL/LVCMOS	16, 12, 8, 4	12, 8, 4
1.8-V LVTTL/LVCMOS	12, 10, 8, 6, 4, 2	8, 6, 4, 2
1.5-V LVCMOS	8, 6, 4, 2	4, 2
SSTL-2 Class I	12, 8	12, 8
SSTL-2 Class II	24, 20, 16	16
SSTL-18 Class I	12, 10, 8, 6, 4	10, 8, 6, 4
SSTL-18 Class II	20, 18, 16, 8	—
HSTL-18 Class I	12, 10, 8, 6, 4	12, 10, 8, 6, 4
HSTL-18 Class II	20, 18, 16	—
HSTL-15 Class I	12, 10, 8, 6, 4	8, 6, 4
HSTL-15 Class II	20, 18, 16	—

Note to Table 2–24:

(1) The Quartus II software default current setting is the maximum setting for each I/O standard.

Open-Drain Output

Arria GX devices provide an optional open-drain (equivalent to an open collector) output for each I/O pin. This open-drain output enables the device to provide system-level control signals (for example, interrupt and write enable signals) that can be asserted by any of several devices.

Bus Hold

Each Arria GX device I/O pin provides an optional bus-hold feature. Bus-hold circuitry can hold the signal on an I/O pin at its last-driven state. Because the bus-hold feature holds the last-driven state of the pin until the next input signal is present, an external pull-up or pull-down resistor is not needed to hold a signal level when the bus is tri-stated.

Bus-hold circuitry also pulls undriven pins away from the input threshold voltage where noise can cause unintended high-frequency switching. You can select this feature individually for each I/O pin. The bus-hold output drives no higher than V_{CCIO} to prevent overdriving signals. If the bus-hold feature is enabled, the programmable pull-up option cannot be used. Disable the bus-hold feature when the I/O pin has been configured for differential signals.

Bus-hold circuitry uses a resistor with a nominal resistance (RBH) of approximately 7 kΩ to pull the signal level to the last-driven state. This information is provided for each V_{CCIO} voltage level. Bus-hold circuitry is active only after configuration. When going into user mode, the bus-hold circuit captures the value on the pin present at the end of configuration.

Table 2–25 describes the I/O standards supported by Arria GX devices.

Table 2–25. Arria GX Devices Supported I/O Standards

I/O Standard	Type	Input Reference Voltage (V_{REF}) (V)	Output Supply Voltage (V_{CCIO}) (V)	Board Termination Voltage (V_{TT}) (V)
LVTTL	Single-ended	—	3.3	—
LVCMOS	Single-ended	—	3.3	—
2.5 V	Single-ended	—	2.5	—
1.8 V	Single-ended	—	1.8	—
1.5-V LVCMOS	Single-ended	—	1.5	—
3.3-V PCI	Single-ended	—	3.3	—
3.3-V PCI-X mode 1	Single-ended	—	3.3	—
LVDS	Differential	—	2.5 *(3)*	—
LVPECL *(1)*	Differential	—	3.3	—
HyperTransport technology	Differential	—	2.5 *(3)*	—
Differential 1.5-V HSTL class I and II *(2)*	Differential	0.75	1.5	0.75
Differential 1.8-V HSTL class I and II *(2)*	Differential	0.90	1.8	0.90
Differential SSTL-18 class I and II *(2)*	Differential	0.90	1.8	0.90
Differential SSTL-2 class I and II *(2)*	Differential	1.25	2.5	1.25
1.2-V HSTL *(4)*	Voltage-referenced	0.6	1.2	0.6
1.5-V HSTL class I and II	Voltage-referenced	0.75	1.5	0.75
1.8-V HSTL class I and II	Voltage-referenced	0.9	1.8	0.9
SSTL-18 class I and II	Voltage-referenced	0.90	1.8	0.90
SSTL-2 class I and II	Voltage-referenced	1.25	2.5	1.25

Notes to Table 2–25:

(1) This I/O standard is only available on input and output column clock pins.

(2) This I/O standard is only available on input clock pins and DQS pins in I/O banks 3, 4, 7, and 8, and output clock pins in I/O banks 9, 10, 11, and 12.

(3) V_{CCIO} is 3.3 V when using this I/O standard in input and output column clock pins (in I/O banks 3, 4, 7, 8, 9, 10, 11, and 12).

(4) 1.2-V HSTL is only supported in I/O banks 4, 7, and 8.

For more information about the I/O standards supported by Arria GX I/O banks, refer to the *Selectable I/O Standards in Arria GX Devices* chapter.

Arria GX devices contain six I/O banks and four enhanced PLL external clock output banks, as shown in Figure 2–78. The two I/O banks on the left of the device contain circuitry to support source-synchronous, high-speed differential I/O for LVDS inputs and outputs. These banks support all Arria GX I/O standards except PCI or PCI-X I/O pins, and SSTL-18 class II and HSTL outputs. The top and bottom I/O banks support all single-ended I/O standards. Additionally, enhanced PLL external clock output banks allow clock output capabilities such as differential support for SSTL and HSTL.

Table 4–8 and Table 4–9 list the transmitter and receiver PCS latency for each mode, respectively.

Table 4–8. PCS Latency *(Note 1)*

Functional Mode	Configuration	Transmitter PCS Latency					
		TX PIPE	TX Phase Comp FIFO	Byte Serializer	TX State Machine	8B/10B Encoder	Sum *(2)*
XAUI	—	—	2–3	1	0.5	0.5	4–5
PIPE	×1, ×4, ×8 8-bit channel width	1	3–4	1	—	1	6–7
	×1, ×4, ×8 16-bit channel width	1	3–4	1	—	0.5	6–7
GIGE	—	—	2–3	1	—	1	4–5
Serial RapidIO	1.25 Gbps, 2.5 Gbps, 3.125 Gbps	—	2–3	1	—	0.5	4–5
SDI	HD10-bit channel width	—	2–3	1	—	1	4–5
	HD, 3G 20-bit channel width	—	2–3	1	—	0.5	4–5
BASIC Single Width	8-bit/10-bit channel width	—	2–3	1	—	1	4–5
	16-bit/20-bit channel width	—	2–3	1	—	0.5	4–5

Notes to Table 4–8:

(1) The latency numbers are with respect to the PLD-transceiver interface clock cycles.

(2) The total latency number is rounded off in the Sum column.

Table 4–9. PCS Latency (Part 1 of 2) (Part 1 of 2)

Functional Mode	Configuration	Receiver PCS Latency									
		Word Aligner	Deskew FIFO	Rate Matcher *(3)*	8B/10B Decoder	Receiver State Machine	Byte Deserializer	Byte Order	Receiver Phase Comp FIFO	Receiver PIPE	Sum *(2)*
XAUI	—	2–2.5	2–2.5	5.5–6.5	0.5	1	1	1	1–2	—	14–17
PIPE	×1, ×4 8-bit channel width	4–5	—	11–13	1	—	1	1	2–3	1	21–25
	×1, ×4 16-bit channel width	2–2.5	—	5.5–6.5	0.5	—	1	1	2–3	1	13–16
GIGE	—	4–5	—	11–13	1	—	1	1	1–2	—	19–23
Serial RapidIO	1.25 Gbps, 2.5 Gbps, 3.125 Gbps	2–2.5	—	—	0.5	—	1	1	1–2	—	6–7
SDI	HD 10-bit channel width	5	—	—	1	—	1	1	1–2	—	9–10
	HD, 3G 20-bit channel width	2.5	—	—	0.5	—	1	1	1–2	—	6–7

Figure 4–5. Receiver Input Waveforms for Differential I/O Standards

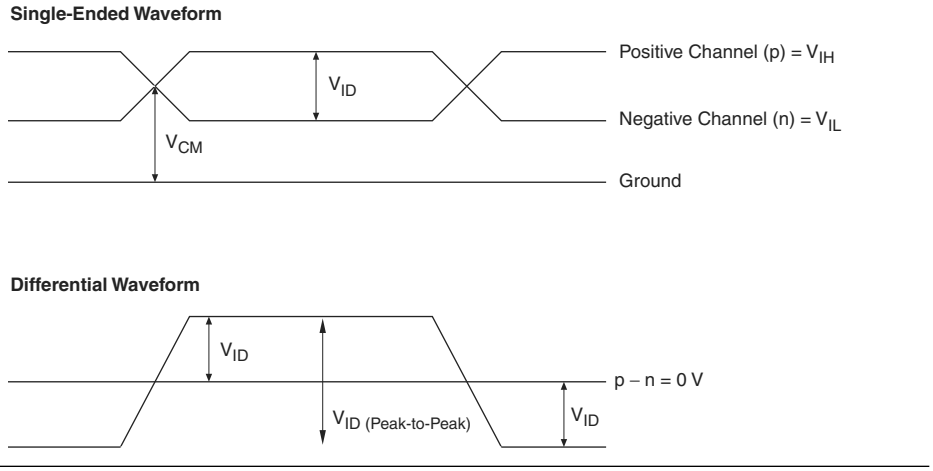


Figure 4–6. Transmitter Output Waveforms for Differential I/O Standards

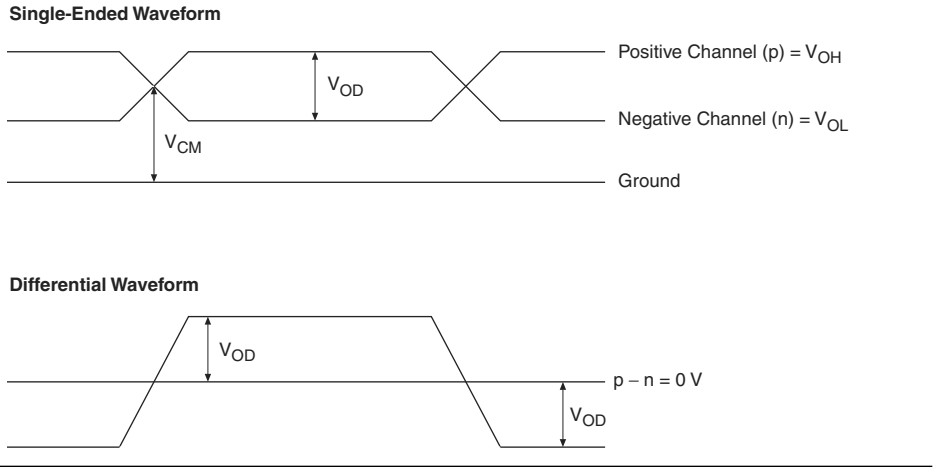


Table 4–20. 2.5-V LVDS I/O Specifications

Symbol	Parameter	Conditions	Minimum	Typical	Maximum	Units
V_{CCIO}	I/O supply voltage for left and right I/O banks (1, 2, 5, and 6)	—	2.375	2.5	2.625	V
V_{ID}	Input differential voltage swing (single-ended)	—	100	350	900	mV
V_{ICM}	Input common mode voltage	—	200	1,250	1,800	mV
V_{OD}	Output differential voltage (single-ended)	R_L = 100 Ω	250	—	450	mV
V_{OCM}	Output common mode voltage	R_L = 100 Ω	1.125	—	1.375	V
R_L	Receiver differential input discrete resistor (external to Arria GX devices)	—	90	100	110	Ω

Table 4–66. EP1AGX60 Row Pins Input Timing Parameters (Part 3 of 3)

I/O Standard	Clock	Parameter	Fast Model		–6 Speed Grade	Units
			Industrial	Commercial		
1.5-V HSTL CLASS II	GCLK	t_{SU}	1.281	1.281	2.777	ns
		t_H	–1.176	–1.176	–2.500	ns
	GCLK PLL	t_{SU}	2.853	2.853	6.220	ns
		t_H	–2.748	–2.748	–5.943	ns
LVDS	GCLK	t_{SU}	1.208	1.208	2.664	ns
		t_H	–1.103	–1.103	–2.387	ns
	GCLK PLL	t_{SU}	2.767	2.767	6.083	ns
		t_H	–2.662	–2.662	–5.806	ns

Table 4–67 lists I/O timing specifications.

Table 4–67. EP1AGX60 Column Pins Input Timing Parameters (Part 1 of 3)

I/O Standard	Clock	Parameter	Fast Corner		–6 Speed Grade	Units
			Industrial	Commercial		
3.3-V LVTTL	GCLK	t_{SU}	1.124	1.124	2.493	ns
		t_H	–1.019	–1.019	-2.216	ns
	GCLK PLL	t_{SU}	2.694	2.694	5.928	ns
		t_H	–2.589	–2.589	-5.651	ns
3.3-V LVCMOS	GCLK	t_{SU}	1.124	1.124	2.493	ns
		t_H	–1.019	–1.019	-2.216	ns
	GCLK PLL	t_{SU}	2.694	2.694	5.928	ns
		t_H	–2.589	–2.589	-5.651	ns
2.5 V	GCLK	t_{SU}	1.134	1.134	2.475	ns
		t_H	–1.029	–1.029	-2.198	ns
	GCLK PLL	t_{SU}	2.704	2.704	5.910	ns
		t_H	–2.599	–2.599	-5.633	ns
1.8 V	GCLK	t_{SU}	1.200	1.200	2.685	ns
		t_H	–1.095	–1.095	-2.408	ns
	GCLK PLL	t_{SU}	2.770	2.770	6.120	ns
		t_H	–2.665	–2.665	-5.843	ns
1.5 V	GCLK	t_{SU}	1.203	1.203	2.778	ns
		t_H	–1.098	–1.098	-2.501	ns
	GCLK PLL	t_{SU}	2.773	2.773	6.213	ns
		t_H	–2.668	–2.668	-5.936	ns
SSTL-2 CLASS I	GCLK	t_{SU}	0.948	0.948	1.951	ns
		t_H	–0.843	–0.843	-1.674	ns
	GCLK PLL	t_{SU}	2.519	2.519	5.388	ns
		t_H	–2.414	–2.414	-5.111	ns

Table 4–68. EP1AGX60 Row Pins Output Timing Parameters (Part 2 of 2)

I/O Standard	Drive Strength	Clock	Parameter	Fast Model		–6 Speed Grade	Units
				Industrial	Commercial		
SSTL-2 CLASS I	8 mA	GCLK	t_{CO}	2.774	2.774	6.057	ns
		GCLK PLL	t_{CO}	1.211	1.211	2.633	ns
SSTL-2 CLASS I	12 mA	GCLK	t_{CO}	2.750	2.750	5.981	ns
		GCLK PLL	t_{CO}	1.187	1.187	2.557	ns
SSTL-2 CLASS II	16 mA	GCLK	t_{CO}	2.716	2.716	5.850	ns
		GCLK PLL	t_{CO}	1.153	1.153	2.426	ns
SSTL-18 CLASS I	4 mA	GCLK	t_{CO}	2.776	2.776	6.025	ns
		GCLK PLL	t_{CO}	1.204	1.204	2.582	ns
SSTL-18 CLASS I	6 mA	GCLK	t_{CO}	2.780	2.780	5.954	ns
		GCLK PLL	t_{CO}	1.208	1.208	2.511	ns
SSTL-18 CLASS I	8 mA	GCLK	t_{CO}	2.756	2.756	5.937	ns
		GCLK PLL	t_{CO}	1.184	1.184	2.494	ns
SSTL-18 CLASS I	10 mA	GCLK	t_{CO}	2.759	2.759	5.916	ns
		GCLK PLL	t_{CO}	1.187	1.187	2.473	ns
1.8-V HSTL CLASS I	4 mA	GCLK	t_{CO}	2.757	2.757	5.935	ns
		GCLK PLL	t_{CO}	1.185	1.185	2.492	ns
1.8-V HSTL CLASS I	6 mA	GCLK	t_{CO}	2.760	2.760	5.899	ns
		GCLK PLL	t_{CO}	1.188	1.188	2.456	ns
1.8-V HSTL CLASS I	8 mA	GCLK	t_{CO}	2.742	2.742	5.895	ns
		GCLK PLL	t_{CO}	1.170	1.170	2.452	ns
1.8-V HSTL CLASS I	10 mA	GCLK	t_{CO}	2.746	2.746	5.884	ns
		GCLK PLL	t_{CO}	1.174	1.174	2.441	ns
1.8-V HSTL CLASS I	12 mA	GCLK	t_{CO}	2.737	2.737	5.883	ns
		GCLK PLL	t_{CO}	1.165	1.165	2.440	ns
1.5-V HSTL CLASS I	4 mA	GCLK	t_{CO}	2.756	2.756	5.912	ns
		GCLK PLL	t_{CO}	1.184	1.184	2.469	ns
1.5-V HSTL CLASS I	6 mA	GCLK	t_{CO}	2.759	2.759	5.898	ns
		GCLK PLL	t_{CO}	1.187	1.187	2.455	ns
1.5-V HSTL CLASS I	8 mA	GCLK	t_{CO}	2.744	2.744	5.890	ns
		GCLK PLL	t_{CO}	1.172	1.172	2.447	ns
LVDS	—	GCLK	t_{CO}	2.787	2.787	6.037	ns
		GCLK PLL	t_{CO}	1.228	1.228	2.618	ns

Table 4–72. EP1AGX90 Row Pins Input Timing Parameters (Part 2 of 2)

I/O Standard	Clock	Parameter	Fast Model		–6 Speed Grade	Units
			Industrial	Commercial		
1.8-V HSTL CLASS I	GCLK	t_{SU}	1.159	1.159	2.447	ns
		t_H	–1.054	–1.054	–2.170	ns
	GCLK PLL	t_{SU}	3.212	3.212	6.565	ns
		t_H	–3.107	–3.107	–6.288	ns
1.8-V HSTL CLASS II	GCLK	t_{SU}	1.157	1.157	2.441	ns
		t_H	–1.052	–1.052	–2.164	ns
	GCLK PLL	t_{SU}	3.235	3.235	6.597	ns
		t_H	–3.130	–3.130	–6.320	ns
1.5-V HSTL CLASS I	GCLK	t_{SU}	1.185	1.185	2.575	ns
		t_H	–1.080	–1.080	–2.298	ns
	GCLK PLL	t_{SU}	3.238	3.238	6.693	ns
		t_H	–3.133	–3.133	–6.416	ns
1.5-V HSTL CLASS II	GCLK	t_{SU}	1.183	1.183	2.569	ns
		t_H	–1.078	–1.078	–2.292	ns
	GCLK PLL	t_{SU}	3.261	3.261	6.725	ns
		t_H	–3.156	–3.156	–6.448	ns
LVDS	GCLK	t_{SU}	1.098	1.098	2.439	ns
		t_H	–0.993	–0.993	–2.162	ns
	GCLK PLL	t_{SU}	3.160	3.160	6.566	ns
		t_H	–3.055	–3.055	–6.289	ns

Table 4–73 lists I/O timing specifications.

Table 4–73. EP1AGX90 Column Pins Input Timing Parameters (Part 1 of 3)

I/O Standard	Clock	Parameter	Fast Corner		–6 Speed Grade	Units
			Industrial	Commercial		
3.3-V LVTTL	GCLK	t_{SU}	1.018	1.018	2.290	ns
		t_H	–0.913	–0.913	–2.013	ns
	GCLK PLL	t_{SU}	3.082	3.082	6.425	ns
		t_H	–2.977	–2.977	–6.148	ns
3.3-V LVCMOS	GCLK	t_{SU}	1.018	1.018	2.290	ns
		t_H	–0.913	–0.913	–2.013	ns
	GCLK PLL	t_{SU}	3.082	3.082	6.425	ns
		t_H	–2.977	–2.977	–6.148	ns
2.5 V	GCLK	t_{SU}	1.028	1.028	2.272	ns
		t_H	–0.923	–0.923	–1.995	ns
	GCLK PLL	t_{SU}	3.092	3.092	6.407	ns
		t_H	–2.987	–2.987	–6.130	ns

Table 4–75. EP1AGX90 Column Pins Output Timing Parameters (Part 3 of 4)

I/O Standard	Drive Strength	Clock	Parameter	Fast Corner		–6 Speed Grade	Units
				Industrial	Commercial		
SSTL-18 CLASS I	6 mA	GCLK	t_{CO}	2.860	2.860	6.313	ns
		GCLK PLL	t_{CO}	0.798	0.798	2.182	ns
SSTL-18 CLASS I	8 mA	GCLK	t_{CO}	2.839	2.839	6.294	ns
		GCLK PLL	t_{CO}	0.777	0.777	2.163	ns
SSTL-18 CLASS I	10 mA	GCLK	t_{CO}	2.844	2.844	6.292	ns
		GCLK PLL	t_{CO}	0.782	0.782	2.161	ns
SSTL-18 CLASS I	12 mA	GCLK	t_{CO}	2.838	2.838	6.278	ns
		GCLK PLL	t_{CO}	0.776	0.776	2.147	ns
SSTL-18 CLASS II	8 mA	GCLK	t_{CO}	2.827	2.827	6.244	ns
		GCLK PLL	t_{CO}	0.765	0.765	2.113	ns
SSTL-18 CLASS II	16 mA	GCLK	t_{CO}	2.839	2.839	6.222	ns
		GCLK PLL	t_{CO}	0.777	0.777	2.091	ns
SSTL-18 CLASS II	18 mA	GCLK	t_{CO}	2.835	2.835	6.230	ns
		GCLK PLL	t_{CO}	0.773	0.773	2.099	ns
SSTL-18 CLASS II	20 mA	GCLK	t_{CO}	2.835	2.835	6.228	ns
		GCLK PLL	t_{CO}	0.773	0.773	2.097	ns
1.8-V HSTL CLASS I	4 mA	GCLK	t_{CO}	2.861	2.861	6.287	ns
		GCLK PLL	t_{CO}	0.797	0.797	2.152	ns
1.8-V HSTL CLASS I	6 mA	GCLK	t_{CO}	2.864	2.864	6.268	ns
		GCLK PLL	t_{CO}	0.802	0.802	2.137	ns
1.8-V HSTL CLASS I	8 mA	GCLK	t_{CO}	2.842	2.842	6.257	ns
		GCLK PLL	t_{CO}	0.780	0.780	2.126	ns
1.8-V HSTL CLASS I	10 mA	GCLK	t_{CO}	2.846	2.846	6.263	ns
		GCLK PLL	t_{CO}	0.784	0.784	2.132	ns
1.8-V HSTL CLASS I	12 mA	GCLK	t_{CO}	2.838	2.838	6.256	ns
		GCLK PLL	t_{CO}	0.776	0.776	2.125	ns
1.8-V HSTL CLASS II	16 mA	GCLK	t_{CO}	2.821	2.821	6.020	ns
		GCLK PLL	t_{CO}	0.759	0.759	1.889	ns
1.8-V HSTL CLASS II	18 mA	GCLK	t_{CO}	2.823	2.823	6.031	ns
		GCLK PLL	t_{CO}	0.761	0.761	1.900	ns
1.8-V HSTL CLASS II	20 mA	GCLK	t_{CO}	2.823	2.823	6.040	ns
		GCLK PLL	t_{CO}	0.761	0.761	1.909	ns
1.5-V HSTL CLASS I	4 mA	GCLK	t_{CO}	2.861	2.861	6.286	ns
		GCLK PLL	t_{CO}	0.797	0.797	2.151	ns
1.5-V HSTL CLASS I	6 mA	GCLK	t_{CO}	2.863	2.863	6.260	ns
		GCLK PLL	t_{CO}	0.801	0.801	2.129	ns
1.5-V HSTL CLASS I	8 mA	GCLK	t_{CO}	2.845	2.845	6.262	ns
		GCLK PLL	t_{CO}	0.783	0.783	2.131	ns

Table 4–77 lists column pin delay adders when using the regional clock in Arria GX devices.

Table 4–77. EP1AGX90 Column Pin Delay Adders for Regional Clock

Parameter	Fast Corner		–6 Speed Grade	Units
	Industrial	Commercial		
RCLK input adder	0.138	0.138	0.354	ns
RCLK PLL input adder	–1.697	–1.697	–3.607	ns
RCLK output adder	–0.138	–0.138	–0.353	ns
RCLK PLL output adder	1.966	1.966	5.188	ns

Dedicated Clock Pin Timing

Table 4–79 through Table 4–98 list clock pin timing for Arria GX devices when the clock is driven by the global clock, regional clock, periphery clock, and a PLL.

Table 4–78 lists Arria GX clock timing parameters.

Table 4–78. Arria GX Clock Timing Parameters

Symbol	Parameter
t_{CIN}	Delay from clock pad to I/O input register
t_{COUT}	Delay from clock pad to I/O output register
t_{PLLCIN}	Delay from PLL inclk pad to I/O input register
$t_{PLLCOUT}$	Delay from PLL inclk pad to I/O output register

EP1AGX20 Clock Timing Parameters

Table 4–79 through Table 4–80 list the GCLK clock timing parameters for EP1AGX20 devices.

Table 4–79 lists clock timing specifications.

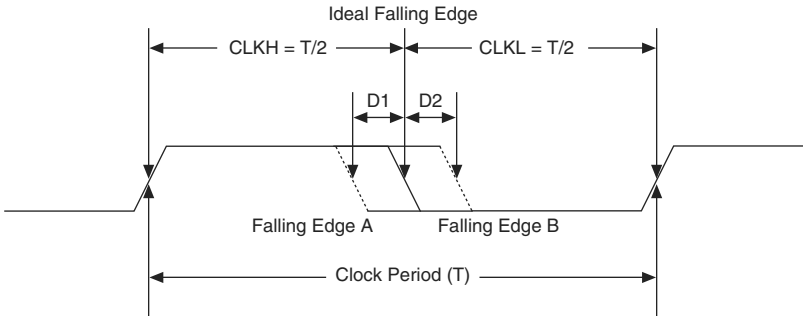
Table 4–79. EP1AGX20 Row Pins Global Clock Timing Parameters

Parameter	Fast Model		–6 Speed Grade	Units
	Industrial	Commercial		
tcin	1.394	1.394	3.161	ns
tcout	1.399	1.399	3.155	ns
tpllcin	–0.027	–0.027	0.091	ns
tpllcout	–0.022	–0.022	0.085	ns

Table 4–107. Arria GX Maximum Output Clock Rate for Dedicated Clock Pins (Part 2 of 4)

I/O Standards	Drive Strength	–6 Speed Grade	Units
SSTL-2 CLASS I	8 mA	280	MHz
	12 mA	327	MHz
SSTL-2 CLASS II	16 mA	280	MHz
	20 mA	327	MHz
	24 mA	327	MHz
SSTL-18 CLASS I	4 mA	140	MHz
	6 mA	186	MHz
	8 mA	280	MHz
	10 mA	373	MHz
	12 mA	373	MHz
SSTL-18 CLASS II	8 mA	140	MHz
	16 mA	327	MHz
	18 mA	373	MHz
	20 mA	420	MHz
1.8-V HSTL CLASS I	4 mA	280	MHz
	6 mA	420	MHz
	8 mA	561	MHz
	10 mA	561	MHz
	12 mA	607	MHz
1.8-V HSTL CLASS II	16 mA	420	MHz
	18 mA	467	MHz
	20 mA	514	MHz
1.5-V HSTL CLASS I	4 mA	280	MHz
	6 mA	420	MHz
	8 mA	561	MHz
	10mA	607	MHz
	12 mA	654	MHz
1.5-V HSTL CLASS II	16 mA	514	MHz
	18 mA	561	MHz
	20 mA	561	MHz
	24 mA	278	MHz
DIFFERENTIAL SSTL-2	8 mA	280	MHz
	12 mA	327	MHz
DIFFERENTIAL 2.5-V SSTL CLASS II	16 mA	280	MHz
	20 mA	327	MHz
	24 mA	327	MHz

Figure 4–10. Duty Cycle Distortion



DCD expressed in absolution derivation, for example, D1 or D2 in Figure 4–10, is clock-period independent. DCD can also be expressed as a percentage, and the percentage number is clock-period dependent. DCD as a percentage is defined as:

(T/2 – D1) / T (the low percentage boundary)

(T/2 + D2) / T (the high percentage boundary)

DCD Measurement Techniques

DCD is measured at an FPGA output pin driven by registers inside the corresponding I/O element (IOE) block. When the output is a single data rate signal (non-DDIO), only one edge of the register input clock (positive or negative) triggers output transitions (Figure 4–11). Therefore, any DCD present on the input clock signal or caused by the clock input buffer or different input I/O standard does not transfer to the output signal.

Figure 4–11. DCD Measurement Technique for Non-DDIO (Single-Data Rate) Outputs

However, when the output is a double data rate input/output (DDIO) signal, both edges of the input clock signal (positive and negative) trigger output transitions (Figure 4–12). Therefore, any distortion on the input clock and the input clock buffer affect the output DCD.

Figure 4–12. DCD Measurement Technique for DDIO (Double-Data Rate) Outputs

When an FPGA PLL generates the internal clock, the PLL output clocks the IOE block. As the PLL only monitors the positive edge of the reference clock input and internally re-creates the output clock signal, any DCD present on the reference clock is filtered out. Therefore, the DCD for a DDIO output with PLL in the clock path is better than the DCD for a DDIO output without PLL in the clock path.

Table 4–108 through Table 4–113 show the maximum DCD in absolution derivation for different I/O standards on Arria GX devices. Examples are also provided that show how to calculate DCD as a percentage.

Table 4–108. Maximum DCD for Non-DDIO Output on Row I/O Pins

Row I/O Output Standard	Maximum DCD (ps) for Non-DDIO Output	
	–6 Speed Grade	Units
3.3-V LVTTTL	275	ps
3.3-V LVCMOS	155	ps
2.5 V	135	ps
1.8 V	180	ps
1.5-V LVCMOS	195	ps
SSTL-2 Class I	145	ps
SSTL-2 Class II	125	ps
SSTL-18 Class I	85	ps
1.8-V HSTL Class I	100	ps
1.5-V HSTL Class I	115	ps
LVDS	80	ps

Here is an example for calculating the DCD as a percentage for a non-DDIO output on a row I/O:

If the non-DDIO output I/O standard is SSTL-2 Class II, the maximum DCD is 125 ps (see Table 4–109). If the clock frequency is 267 MHz, the clock period T is:

$$T = 1/f = 1 / 267\ \text{MHz} = 3.745\ \text{ns} = 3{,}745\ \text{ps}$$

Table 4–112. Maximum DCD for DDIO Output on Row I/O Pins With PLL in the Clock Path

Maximum DCD (ps) for Row DDIO Output I/O Standard	Arria GX Devices (PLL Output Feeding DDIO)	Units
	–6 Speed Grade	
SSTL-18 Class I	65	ps
1.8-V HSTL Class I	70	ps
1.5-V HSTL Class I	70	ps
LVDS	180	ps

Table 4–113. Maximum DCD for DDIO Output on Column I/O Pins With PLL in the Clock Path

Maximum DCD (ps) for Column DDIO Output I/O Standard	Arria GX Devices (PLL Output Feeding DDIO)	Units
	–6 Speed Grade	
3.3-V LVTTL	160	ps
3.3-V LVCMOS	110	ps
2.5V	95	ps
1.8V	100	ps
1.5-V LVCMOS	155	ps
SSTL-2 Class I	75	ps
SSTL-2 Class II	70	ps
SSTL-18 Class I	65	ps
SSTL-18 Class II	80	ps
1.8-V HSTL Class I	70	ps
1.8-V HSTL Class II	70	ps
1.5-V HSTL Class I	70	ps
1.5-V HSTL Class II	100	ps
1.2-V HSTL	155	ps
LVPECL	180	ps

High-Speed I/O Specifications

Table 4–114 lists high-speed timing specifications definitions.

Table 4–114. High-Speed Timing Specifications and Definitions (Part 1 of 2)

High-Speed Timing Specifications	Definitions
t_C	High-speed receiver/transmitter input and output clock period.
f_{HSCLK}	High-speed receiver/transmitter input and output clock frequency.
J	Deserialization factor (width of parallel data bus).
W	PLL multiplication factor.
t_{RISE}	Low-to-high transmission time.
t_{FALL}	High-to-low transmission time.

Document Revision History

Table 4–124 lists the revision history for this chapter.

Table 4–124. Document Revision History

Date and Document Version	Changes Made	Summary of Changes
December 2009, v2.0	■ Updated Table 4–104, Table 4–105, and Table 4–106. ■ Document template update. ■ Minor text edits.	—
April 2009 v1.4	■ Updated Table 4–6 and Table 4–7. ■ Updated "Maximum Input and Output Clock Toggle Rate" section.	—
May 2008 v1.3	Updated: ■ Table 4–5 ■ Table 4–7 ■ Table 4–8 ■ Table 4–9 ■ Table 4–10 ■ Table 4–11 ■ Table 4–12 ■ Table 4–13 ■ Table 4–14 ■ Table 4–15 ■ Table 4–16 ■ Table 4–17 ■ Table 4–43 ■ Table 4–116 ■ Table 4–117	—
	Updated: ■ Figure 4–4	—
	Minor text edits.	—
August 2007 v1.2	Removed "Preliminary" from each page.	—
	Removed "Preliminary" note from Tables 4–44, 4–45, and 4–47.	—
	Added "Referenced Documents" section.	—
June 2007 v1.1	Updated Table 4–99.	—
	Added GIGE information.	—
May 2007 v1.0	Initial release.	—