Intel - EP2S180F1508I4N 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	Obsolete
Number of LABs/CLBs	8970
Number of Logic Elements/Cells	179400
Total RAM Bits	9383040
Number of I/O	1170
Number of Gates	-
Voltage - Supply	1.15V ~ 1.25V
Mounting Type	Surface Mount
Operating Temperature	-40°C ~ 100°C (TJ)
Package / Case	1508-BBGA, FCBGA
Supplier Device Package	1508-FBGA, FC (40x40)
Purchase URL	https://www.e-xfl.com/product-detail/intel/ep2s180f1508i4n

Chapter 6. Reference & Ordering Information

Stratix II devices are available in up to three speed grades, -3, -4, and -5, with -3 being the fastest. Table 1–5 shows Stratix II device speed-grade offerings.

Table 1–5. Stratix II Device Speed Grades

Device	Temperature Grade	484-Pin FineLine BGA	484-Pin Hybrid FineLine BGA	672-Pin FineLine BGA	780-Pin FineLine BGA	1,020-Pin FineLine BGA	1,508-Pin FineLine BGA
EP2S15	Commercial	-3, -4, -5		-3, -4, -5			
	Industrial	-4		-4			
EP2S30	Commercial	-3, -4, -5		-3, -4, -5			
	Industrial	-4		-4			
EP2S60	Commercial	-3, -4, -5		-3, -4, -5		-3, -4, -5	
	Industrial	-4		-4		-4	
EP2S90	Commercial		-4, -5		-4, -5	-3, -4, -5	-3, -4, -5
	Industrial					-4	-4
EP2S130	Commercial				-4, -5	-3, -4, -5	-3, -4, -5
	Industrial					-4	-4
EP2S180	Commercial					-3, -4, -5	-3, -4, -5
	Industrial					-4	-4

The number of M512 RAM, M4K RAM, and DSP blocks varies by device along with row and column numbers and M-RAM blocks. Table 2–1 lists the resources available in Stratix II devices.

Table 2–1. Stratix II Device Resources

Device	M512 RAM Columns/Blocks	M4K RAM Columns/Blocks	M-RAM Blocks	DSP Block Columns/Blocks	LAB Columns	LAB Rows
EP2S15	4 / 104	3 / 78	0	2 / 12	30	26
EP2S30	6 / 202	4 / 144	1	2 / 16	49	36
EP2S60	7 / 329	5 / 255	2	3 / 36	62	51
EP2S90	8 / 488	6 / 408	4	3 / 48	71	68
EP2S130	9 / 699	7 / 609	6	3 / 63	81	87
EP2S180	11 / 930	8 / 768	9	4 / 96	100	96

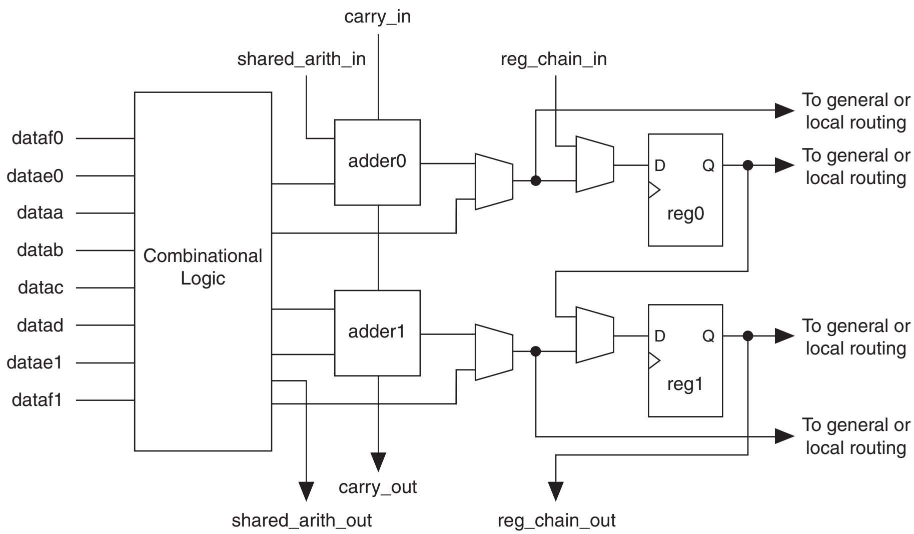
Logic Array Blocks

Each LAB consists of eight ALMs, carry chains, shared arithmetic chains, LAB control signals, local interconnect, and register chain connection lines. The local interconnect transfers signals between ALMs in the same LAB. Register chain connections transfer the output of an ALM register to the adjacent ALM register in an LAB. The Quartus® II Compiler places associated logic in an LAB or adjacent LABs, allowing the use of local, shared arithmetic chain, and register chain connections for performance and area efficiency. Figure 2–2 shows the Stratix II LAB structure.

completely backward-compatible with four-input LUT architectures. One ALM can also implement any function of up to six inputs and certain seven-input functions.

In addition to the adaptive LUT-based resources, each ALM contains two programmable registers, two dedicated full adders, a carry chain, a shared arithmetic chain, and a register chain. Through these dedicated resources, the ALM can efficiently implement various arithmetic functions and shift registers. Each ALM drives all types of interconnects: local, row, column, carry chain, shared arithmetic chain, register chain, and direct link interconnects. Figure 2–5 shows a high-level block diagram of the Stratix II ALM while Figure 2–6 shows a detailed view of all the connections in the ALM.

Figure 2–5. High-Level Block Diagram of the Stratix II ALM



One ALM contains two programmable registers. Each register has data, clock, clock enable, synchronous and asynchronous clear, asynchronous load data, and synchronous and asynchronous load/preset inputs. Global signals, general-purpose I/O pins, or any internal logic can drive the register's clock and clear control signals. Either general-purpose I/O pins or internal logic can drive the clock enable, preset, asynchronous load, and asynchronous load data. The asynchronous load data input comes from the `datae` or `dataf` input of the ALM, which are the same inputs that can be used for register packing. For combinational functions, the register is bypassed and the output of the LUT drives directly to the outputs of the ALM.

Each ALM has two sets of outputs that drive the local, row, and column routing resources. The LUT, adder, or register output can drive these output drivers independently (see Figure 2–6). For each set of output drivers, two ALM outputs can drive column, row, or direct link routing connections, and one of these ALM outputs can also drive local interconnect resources. This allows the LUT or adder to drive one output while the register drives another output. This feature, called register packing, improves device utilization because the device can use the register and the combinational logic for unrelated functions. Another special packing mode allows the register output to feed back into the LUT of the same ALM so that the register is packed with its own fan-out LUT. This provides another mechanism for improved fitting. The ALM can also drive out registered and unregistered versions of the LUT or adder output.

See the *Performance & Logic Efficiency Analysis of Stratix II Devices White Paper* for more information on the efficiencies of the Stratix II ALM and comparisons with previous architectures.

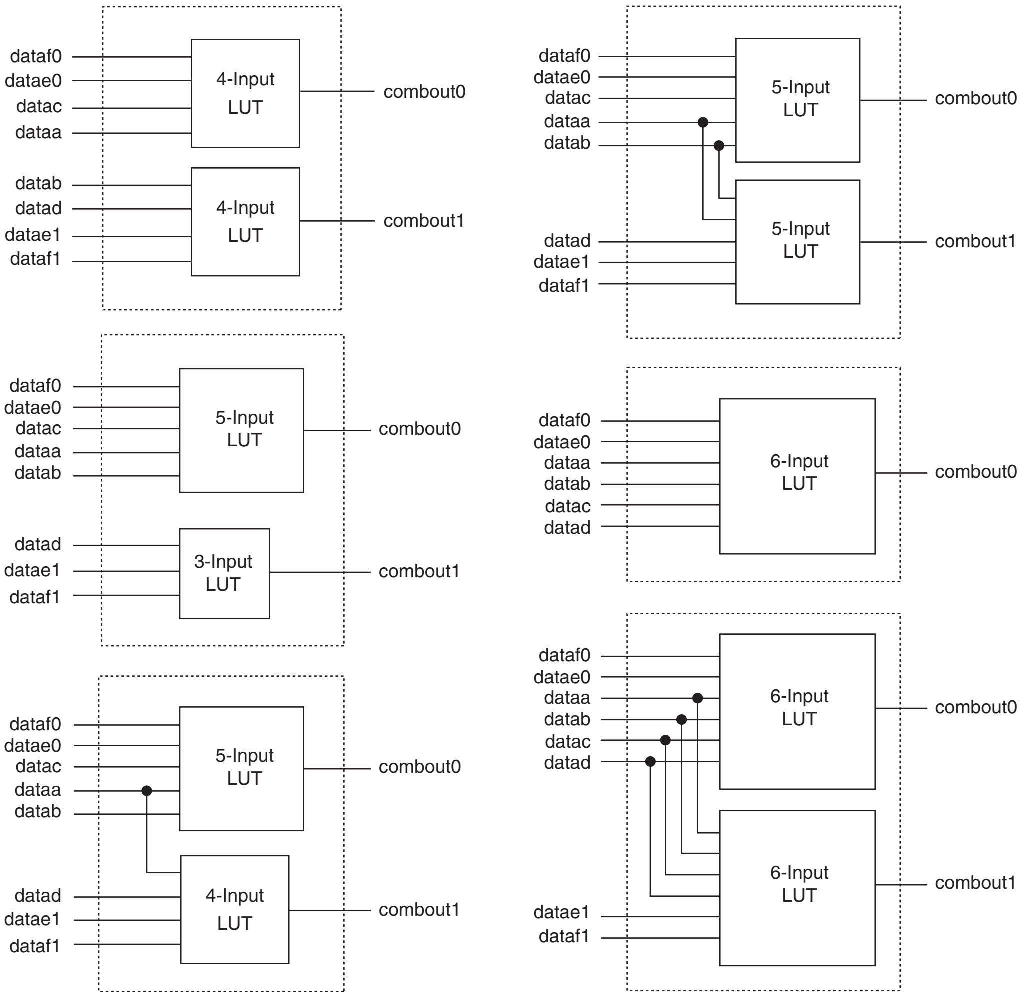
ALM Operating Modes

The Stratix II ALM can operate in one of the following modes:

- Normal mode
- Extended LUT mode
- Arithmetic mode
- Shared arithmetic mode

Each mode uses ALM resources differently. In each mode, eleven available inputs to the ALM--the eight data inputs from the LAB local interconnect; `carry-in` from the previous ALM or LAB; the shared arithmetic chain connection from the previous ALM or LAB; and the register chain connection--are directed to different destinations to implement the desired logic function. LAB-wide signals provide clock, asynchronous clear, asynchronous preset/load, synchronous clear,

Figure 2–7. ALM in Normal Mode *Note (1)*



Note to Figure 2–7:

(1) Combinations of functions with fewer inputs than those shown are also supported. For example, combinations of functions with the following number of inputs are supported: 4 and 3, 3 and 3, 3 and 2, 5 and 2, etc.

The normal mode provides complete backward compatibility with four-input LUT architectures. Two independent functions of four inputs or less can be implemented in one Stratix II ALM. In addition, a five-input function and an independent three-input function can be implemented without sharing inputs.

Table 2–2. Stratix II Device Routing Scheme (Part 2 of 2)

Source	Destination															
	Shared Arithmetic Chain	Carry Chain	Register Chain	Local Interconnect	Direct Link Interconnect	R4 Interconnect	R24 Interconnect	C4 Interconnect	C16 Interconnect	ALM	M512 RAM Block	M4K RAM Block	M-RAM Block	DSP Blocks	Column IOE	Row IOE
Column IOE					✓			✓	✓							
Row IOE					✓	✓	✓	✓								

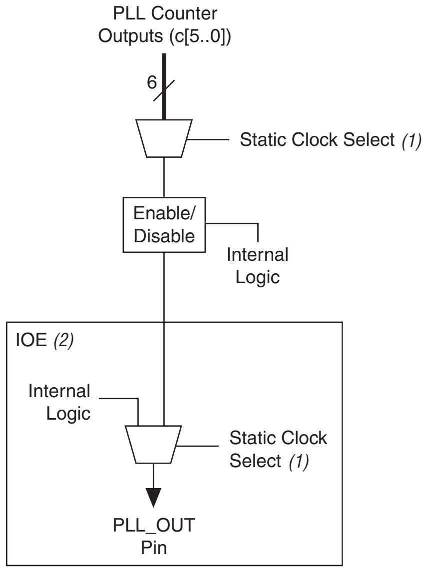
TriMatrix Memory

TriMatrix memory consists of three types of RAM blocks: M512, M4K, and M-RAM. Although these memory blocks are different, they can all implement various types of memory with or without parity, including true dual-port, simple dual-port, and single-port RAM, ROM, and FIFO buffers. Table 2–3 shows the size and features of the different RAM blocks.

Table 2–3. TriMatrix Memory Features (Part 1 of 2)

Memory Feature	M512 RAM Block (32 × 18 Bits)	M4K RAM Block (128 × 36 Bits)	M-RAM Block (4K × 144 Bits)
Maximum performance	500 MHz	550 MHz	420 MHz
True dual-port memory		✓	✓
Simple dual-port memory	✓	✓	✓
Single-port memory	✓	✓	✓
Shift register	✓	✓	
ROM	✓	✓	*(1)*
FIFO buffer	✓	✓	✓
Pack mode		✓	✓
Byte enable	✓	✓	✓
Address clock enable		✓	✓
Parity bits	✓	✓	✓
Mixed clock mode	✓	✓	✓
Memory initialization (**.mif**)	✓	✓	

Figure 2–39. External PLL Output Clock Control Blocks



Notes to Figure 2–39:

(1) These clock select signals can only be set through a configuration file (**.sof** or **.pof**) and cannot be dynamically controlled during user mode operation.

(2) The clock control block feeds to a multiplexer within the `PLL_OUT` pin's IOE. The `PLL_OUT` pin is a dual-purpose pin. Therefore, this multiplexer selects either an internal signal or the output of the clock control block.

For the global clock control block, the clock source selection can be controlled either statically or dynamically. The user has the option of statically selecting the clock source by using the Quartus II software to set specific configuration bits in the configuration file (**.sof** or **.pof**) or the user can control the selection dynamically by using internal logic to drive the multiplexor select inputs. When selecting statically, the clock source can be set to any of the inputs to the select multiplexor. When selecting the clock source dynamically, you can either select between two PLL outputs (such as the C0 or C1 outputs from one PLL), between two PLLs (such as the C0/C1 clock output of one PLL or the C0/C1 c1ock output of the other PLL), between two clock pins (such as `CLK0` or `CLK1`), or between a combination of clock pins or PLL outputs. The clock outputs from corner PLLs cannot be dynamically selected through the global control block.

For the regional and `PLL_OUT` clock control block, the clock source selection can only be controlled statically using configuration bits. Any of the inputs to the clock select multiplexor can be set as the clock source.

- Output drive strength control
- Tri-state buffers
- Bus-hold circuitry
- Programmable pull-up resistors
- Programmable input and output delays
- Open-drain outputs
- DQ and DQS I/O pins
- Double data rate (DDR) registers

The IOE in Stratix II devices contains a bidirectional I/O buffer, six registers, and a latch for a complete embedded bidirectional single data rate or DDR transfer. Figure 2–46 shows the Stratix II IOE structure. The IOE contains two input registers (plus a latch), two output registers, and two output enable registers. The design can use both input registers and the latch to capture DDR input and both output registers to drive DDR outputs. Additionally, the design can use the output enable (OE) register for fast clock-to-output enable timing. The negative edge-clocked OE register is used for DDR SDRAM interfacing. The Quartus II software automatically duplicates a single OE register that controls multiple output or bidirectional pins.

Table 2–14. DQS & DQ Bus Mode Support (Part 2 of 2) Note (1)

Device	Package	Number of ×4 Groups	Number of ×8/×9 Groups	Number of ×16/×18 Groups	Number of ×32/×36 Groups
EP2S90	484-pin Hybrid FineLine BGA	8	4	0	0
	780-pin FineLine BGA	18	8	4	0
	1,020-pin FineLine BGA	36	18	8	4
	1,508-pin FineLine BGA	36	18	8	4
EP2S130	780-pin FineLine BGA	18	8	4	0
	1,020-pin FineLine BGA	36	18	8	4
	1,508-pin FineLine BGA	36	18	8	4
EP2S180	1,020-pin FineLine BGA	36	18	8	4
	1,508-pin FineLine BGA	36	18	8	4

Notes to Table 2–14:

(1) Check the pin table for each DQS/DQ group in the different modes.

A compensated delay element on each DQS pin automatically aligns input DQS synchronization signals with the data window of their corresponding DQ data signals. The DQS signals drive a local DQS bus in the top and bottom I/O banks. This DQS bus is an additional resource to the I/O clocks and is used to clock DQ input registers with the DQS signal.

The Stratix II device has two phase-shifting reference circuits, one on the top and one on the bottom of the device. The circuit on the top controls the compensated delay elements for all DQS pins on the top. The circuit on the bottom controls the compensated delay elements for all DQS pins on the bottom.

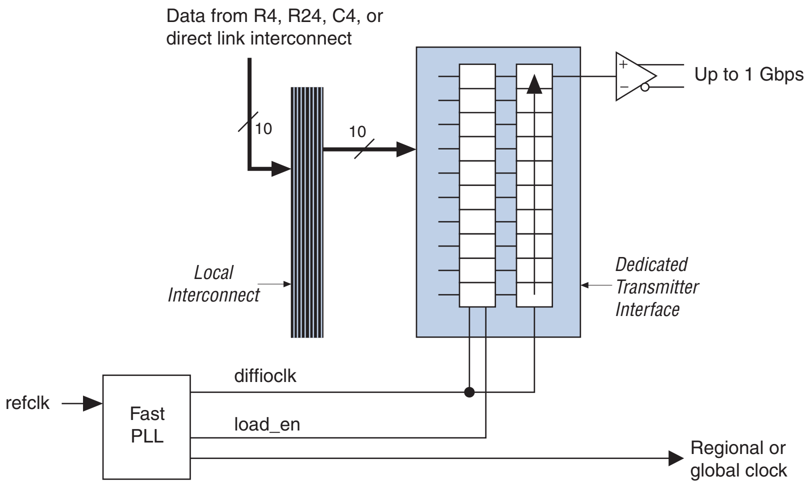
Each phase-shifting reference circuit is driven by a system reference clock, which must have the same frequency as the DQS signal. Clock pins `CLK[15..12]p` feed the phase circuitry on the top of the device and clock pins `CLK[7..4]p` feed the phase circuitry on the bottom of the device. In addition, PLL clock outputs can also feed the phase-shifting reference circuits.

Figure 2–56 illustrates the phase-shift reference circuit control of each DQS delay shift on the top of the device. This same circuit is duplicated on the bottom of the device.

Dedicated Circuitry with DPA Support

Stratix II devices support source-synchronous interfacing with LVDS or HyperTransport signaling at up to 1 Gbps. Stratix II devices can transmit or receive serial channels along with a low-speed or high-speed clock. The receiving device PLL multiplies the clock by an integer factor W = 1 through 32. For example, a HyperTransport technology application where the data rate is 1,000 Mbps and the clock rate is 500 MHz would require that W be set to 2. The SERDES factor *J* determines the parallel data width to deserialize from receivers or to serialize for transmitters. The SERDES factor *J* can be set to 4, 5, 6, 7, 8, 9, or 10 and does not have to equal the PLL clock-multiplication W value. A design using the dynamic phase aligner also supports all of these *J* factor values. For a *J* factor of 1, the Stratix II device bypasses the SERDES block. For a *J* factor of 2, the Stratix II device bypasses the SERDES block, and the DDR input and output registers are used in the IOE. Figure 2–58 shows the block diagram of the Stratix II transmitter channel.

Figure 2–58. Stratix II Transmitter Channel



Each Stratix II receiver channel features a DPA block for phase detection and selection, a SERDES, a synchronizer, and a data realigner circuit. You can bypass the dynamic phase aligner without affecting the basic source-synchronous operation of the channel. In addition, you can dynamically switch between using the DPA block or bypassing the block via a control signal from the logic array. Figure 2–59 shows the block diagram of the Stratix II receiver channel.

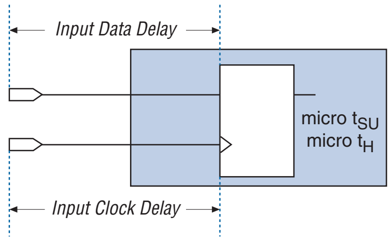
Table 5–10. 2.5-V LVDS I/O Specifications						
Symbol	**Parameter**	**Conditions**	**Minimum**	**Typical**	**Maximum**	**Unit**
V_{CCIO}	I/O supply voltage for left and right I/O banks (1, 2, 5, and 6)		2.375	2.500	2.625	V
V_{ID}	Input differential voltage swing (single-ended)		100	350	900	mV
V_{ICM}	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 Stratix II devices)		90	100	110	Ω

Table 5–11. 3.3-V LVDS I/O Specifications						
Symbol	**Parameter**	**Conditions**	**Minimum**	**Typical**	**Maximum**	**Unit**
V_{CCIO} *(1)*	I/O supply voltage for top and bottom PLL banks (9, 10, 11, and 12)		3.135	3.300	3.465	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		710	mV
V_{OCM}	Output common mode voltage	R_L = 100 Ω	840		1,570	mV
R_L	Receiver differential input discrete resistor (external to Stratix II devices)		90	100	110	Ω

Note to Table 5–11:

(1) The top and bottom clock input differential buffers in I/O banks 3, 4, 7, and 8 are powered by V_{CCINT}, not V_{CCIO}. The PLL clock output/feedback differential buffers are powered by `VCC_PLL_OUT`. For differential clock output/feedback operation, `VCC_PLL_OUT` should be connected to 3.3 V.

Figure 5–3. Input Register Setup & Hold Timing Diagram



For output timing, different I/O standards require different baseline loading techniques for reporting timing delays. Altera characterizes timing delays with the required termination for each I/O standard and with 0 pF (except for PCI and PCI-X which use 10 pF) loading and the timing is specified up to the output pin of the FPGA device. The Quartus II software calculates the I/O timing for each I/O standard with a default baseline loading as specified by the I/O standards.

The following measurements are made during device characterization. Altera measures clock-to-output delays (t_{CO}) at worst-case process, minimum voltage, and maximum temperature (PVT) for default loading conditions shown in Table 5–34. Use the following equations to calculate clock pin to output pin timing for Stratix II devices.

> t_{CO} from clock pin to I/O pin = delay from clock pad to I/O output register + IOE output register clock-to-output delay + delay from output register to output pin + I/O output delay
>
> t_{xz}/t_{zx} from clock pin to I/O pin = delay from clock pad to I/O output register + IOE output register clock-to-output delay + delay from output register to output pin + I/O output delay + output enable pin delay

Simulation using IBIS models is required to determine the delays on the PCB traces in addition to the output pin delay timing reported by the Quartus II software and the timing model in the device handbook.

1. Simulate the output driver of choice into the generalized test setup, using values from Table 5–34.

2. Record the time to V_{MEAS}.

3. Simulate the output driver of choice into the actual PCB trace and load, using the appropriate IBIS model or capacitance value to represent the load.

Table 5–73. Stratix II I/O Input Delay for Column Pins (Part 3 of 3)								
I/O Standard	Parameter	Minimum Timing		-3 Speed Grade (2)	-3 Speed Grade (3)	-4 Speed Grade	-5 Speed Grade	Unit
		Industrial	Commercial					
1.2-V HSTL	t_{PI}	645	677	1194	1252	-	-	ps
	t_{PCOUT}	379	398	758	795	-	-	ps

Notes for Table 5–73:
(1) These I/O standards are only supported on DQS pins.
(2) These numbers apply to -3 speed grade EP2S15, EP2S30, EP2S60, and EP2S90 devices.
(3) These numbers apply to -3 speed grade EP2S130 and EP2S180 devices.

Table 5–74. Stratix II I/O Input Delay for Row Pins (Part 1 of 2)								
I/O Standard	Parameter	Minimum Timing		-3 Speed Grade (1)	-3 Speed Grade (2)	-4 Speed Grade	-5 Speed Grade	Unit
		Industrial	Commercial					
LVTTL	t_{PI}	715	749	1287	1350	1477	1723	ps
	t_{PCOUT}	391	410	760	798	873	1018	ps
2.5 V	t_{PI}	726	761	1273	1335	1461	1704	ps
	t_{PCOUT}	402	422	746	783	857	999	ps
1.8 V	t_{PI}	788	827	1427	1497	1639	1911	ps
	t_{PCOUT}	464	488	900	945	1035	1206	ps
1.5 V	t_{PI}	792	830	1498	1571	1720	2006	ps
	t_{PCOUT}	468	491	971	1019	1116	1301	ps
LVCMOS	t_{PI}	715	749	1287	1350	1477	1723	ps
	t_{PCOUT}	391	410	760	798	873	1018	ps
SSTL-2 Class I	t_{PI}	547	573	879	921	1008	1176	ps
	t_{PCOUT}	223	234	352	369	404	471	ps
SSTL-2 Class II	t_{PI}	547	573	879	921	1008	1176	ps
	t_{PCOUT}	223	234	352	369	404	471	ps
SSTL-18 Class I	t_{PI}	577	605	960	1006	1101	1285	ps
	t_{PCOUT}	253	266	433	454	497	580	ps
SSTL-18 Class II	t_{PI}	577	605	960	1006	1101	1285	ps
	t_{PCOUT}	253	266	433	454	497	580	ps
1.5-V HSTL Class I	t_{PI}	602	631	1056	1107	1212	1413	ps
	t_{PCOUT}	278	292	529	555	608	708	ps

Table 5–75. Stratix II I/O Output Delay for Column Pins (Part 3 of 8)

I/O Standard	Drive Strength	Parameter	Minimum Timing		-3 Speed Grade *(3)*	-3 Speed Grade *(4)*	-4 Speed Grade	-5 Speed Grade	Unit
			Industrial	Commercial					
1.8 V	2 mA	t_{OP}	1042	1093	2904	3048	3338	3472	ps
		t_{DIP}	1062	1115	2970	3118	3414	3562	ps
	4 mA	t_{OP}	1047	1098	2248	2359	2584	2698	ps
		t_{DIP}	1067	1120	2314	2429	2660	2788	ps
	6 mA	t_{OP}	974	1022	2024	2124	2326	2434	ps
		t_{DIP}	994	1044	2090	2194	2402	2524	ps
	8 mA	t_{OP}	976	1024	1947	2043	2238	2343	ps
		t_{DIP}	996	1046	2013	2113	2314	2433	ps
	10 mA	t_{OP}	933	978	1882	1975	2163	2266	ps
		t_{DIP}	953	1000	1948	2045	2239	2356	ps
	12 mA *(1)*	t_{OP}	934	979	1833	1923	2107	2209	ps
		t_{DIP}	954	1001	1899	1993	2183	2299	ps
1.5 V	2 mA	t_{OP}	1023	1073	2505	2629	2879	3002	ps
		t_{DIP}	1043	1095	2571	2699	2955	3092	ps
	4 mA	t_{OP}	963	1009	2023	2123	2325	2433	ps
		t_{DIP}	983	1031	2089	2193	2401	2523	ps
	6 mA	t_{OP}	966	1012	1923	2018	2210	2315	ps
		t_{DIP}	986	1034	1989	2088	2286	2405	ps
	8 mA *(1)*	t_{OP}	926	971	1878	1970	2158	2262	ps
		t_{DIP}	946	993	1944	2040	2234	2352	ps
SSTL-2 Class I	8 mA	t_{OP}	913	957	1715	1799	1971	2041	ps
		t_{DIP}	933	979	1781	1869	2047	2131	ps
	12 mA *(1)*	t_{OP}	896	940	1672	1754	1921	1991	ps
		t_{DIP}	916	962	1738	1824	1997	2081	ps
SSTL-2 Class II	16 mA	t_{OP}	876	918	1609	1688	1849	1918	ps
		t_{DIP}	896	940	1675	1758	1925	2008	ps
	20 mA	t_{OP}	877	919	1598	1676	1836	1905	ps
		t_{DIP}	897	941	1664	1746	1912	1995	ps
	24 mA *(1)*	t_{OP}	872	915	1596	1674	1834	1903	ps
		t_{DIP}	892	937	1662	1744	1910	1993	ps

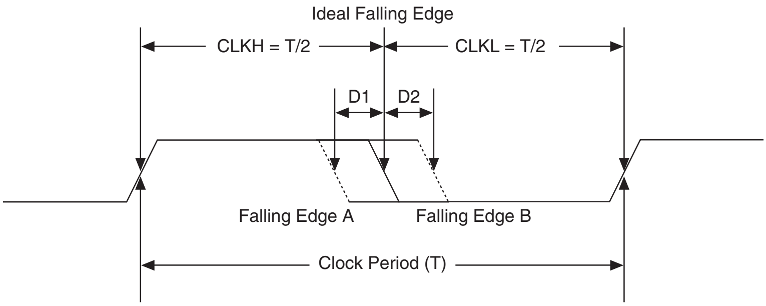
Table 5–78. Maximum Output Toggle Rate on Stratix II Devices (Part 1 of 5) Note (1)

I/O Standard	Drive Strength	Column I/O Pins (MHz)			Row I/O Pins (MHz)			Clock Outputs (MHz)		
		-3	-4	-5	-3	-4	-5	-3	-4	-5
3.3-V LVTTL	4 mA	270	225	210	270	225	210	270	225	210
	8 mA	435	355	325	435	355	325	435	355	325
	12 mA	580	475	420	580	475	420	580	475	420
	16 mA	720	594	520	-	-	-	720	594	520
	20 mA	875	700	610	-	-	-	875	700	610
	24 mA	1,030	794	670	-	-	-	1,030	794	670
3.3-V LVCMOS	4 mA	290	250	230	290	250	230	290	250	230
	8 mA	565	480	440	565	480	440	565	480	440
	12 mA	790	710	670	-	-	-	790	710	670
	16 mA	1,020	925	875	-	-	-	1,020	925	875
	20 mA	1,066	985	935	-	-	-	1,066	985	935
	24 mA	1,100	1,040	1,000	-	-	-	1,100	1,040	1,000
2.5-V LVTTL/LVCMOS	4 mA	230	194	180	230	194	180	230	194	180
	8 mA	430	380	380	430	380	380	430	380	380
	12 mA	630	575	550	630	575	550	630	575	550
	16 mA	930	845	820	-	-	-	930	845	820
1.8-V LVTTL/LVCMOS	2 mA	120	109	104	120	109	104	120	109	104
	4 mA	285	250	230	285	250	230	285	250	230
	6 mA	450	390	360	450	390	360	450	390	360
	8 mA	660	570	520	660	570	520	660	570	520
	10 mA	905	805	755	-	-	-	905	805	755
	12 mA	1,131	1,040	990	-	-	-	1,131	1,040	990
1.5-V LVTTL/LVCMOS	2 mA	244	200	180	244	200	180	244	200	180
	4 mA	470	370	325	470	370	325	470	370	325
	6 mA	550	430	375	-	-	-	550	430	375
	8 mA	625	495	420	-	-	-	625	495	420
SSTL-2 Class I	8 mA	400	300	300	-	-	-	400	300	300
	12 mA	400	400	350	400	350	350	400	400	350
SSTL-2 Class II	16 mA	350	350	300	350	350	300	350	350	300
	20 mA	400	350	350	-	-	-	400	350	350
	24 mA	400	400	350	-	-	-	400	400	350

Table 5–78. Maximum Output Toggle Rate on Stratix II Devices (Part 3 of 5) *Note (1)*

I/O Standard	Drive Strength	Column I/O Pins (MHz)			Row I/O Pins (MHz)			Clock Outputs (MHz)		
		-3	-4	-5	-3	-4	-5	-3	-4	-5
Differential SSTL-18 Class I *(3)*	4 mA	200	150	150	200	150	150	200	150	150
	6 mA	350	250	200	350	250	200	350	250	200
	8 mA	450	300	300	450	300	300	450	300	300
	10 mA	500	400	400	500	400	400	500	400	400
	12 mA	700	550	400	350	350	297	650	550	400
Differential SSTL-18 Class II *(3)*	8 mA	200	200	150	-	-	-	200	200	150
	16 mA	400	350	350	-	-	-	400	350	350
	18 mA	450	400	400	-	-	-	450	400	400
	20 mA	550	500	450	-	-	-	550	500	450
1.8-V Differential HSTL Class I *(3)*	4 mA	300	300	300	-	-	-	300	300	300
	6 mA	500	450	450	-	-	-	500	450	450
	8 mA	650	600	600	-	-	-	650	600	600
	10 mA	700	650	600	-	-	-	700	650	600
	12 mA	700	700	650	-	-	-	700	700	650
1.8-V Differential HSTL Class II *(3)*	16 mA	500	500	450	-	-	-	500	500	450
	18 mA	550	500	500	-	-	-	550	500	500
	20 mA	650	550	550	-	-	-	550	550	550
1.5-V Differential HSTL Class I *(3)*	4 mA	350	300	300	-	-	-	350	300	300
	6 mA	500	500	450	-	-	-	500	500	450
	8 mA	700	650	600	-	-	-	700	650	600
	10 mA	700	700	650	-	-	-	700	700	650
	12 mA	700	700	700	-	-	-	700	700	700
1.5-V Differential HSTL Class II *(3)*	16 mA	600	600	550	-	-	-	600	600	550
	18 mA	650	600	600	-	-	-	650	600	600
	20 mA	700	650	600	-	-	-	700	650	600
3.3-V PCI		1,000	790	670	-	-	-	1,000	790	670
3.3-V PCI-X		1,000	790	670	-	-	-	1,000	790	670
LVDS *(6)*		-	-	-	500	500	500	450	400	300
HyperTransport technology *(4)*, *(6)*					500	500	500	-	-	-
LVPECL *(5)*		-	-	-	-	-	-	450	400	300
3.3-V LVTTL	OCT 50 Ω	400	400	350	400	400	350	400	400	350
2.5-V LVTTL	OCT 50 Ω	350	350	300	350	350	300	350	350	300

Figure 5–7. Duty Cycle Distortion



DCD expressed in absolution derivation, for example, D1 or D2 in Figure 5–7, 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 5–8). 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 5–8. DCD Measurement Technique for Non-DDIO (Single-Data Rate) Outputs

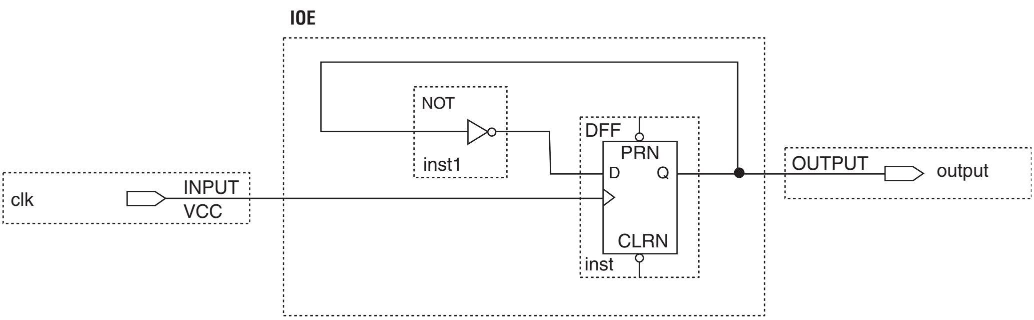


Table 5–92. Enhanced PLL Specifications (Part 2 of 2)

Name	Description	Min	Typ	Max	Unit
t_{LOCK}	Time required for the PLL to lock from the time it is enabled or the end of device configuration		0.03	1	ms
t_{DLOCK}	Time required for the PLL to lock dynamically after automatic clock switchover between two identical clock frequencies			1	ms
$f_{SWITCHOVER}$	Frequency range where the clock switchover performs properly	4		500	MHz
f_{CLBW}	PLL closed-loop bandwidth	0.13	1.20	16.90	MHz
f_{VCO}	PLL VCO operating range for –3 and –4 speed grade devices	300		1,040	MHz
	PLL VCO operating range for –5 speed grade devices	300		840	MHz
f_{SS}	Spread-spectrum modulation frequency	30		150	kHz
% spread	Percent down spread for a given clock frequency	0.4	0.5	0.6	%
t_{PLL_PSERR}	Accuracy of PLL phase shift			±15	ps
t_{ARESET}	Minimum pulse width on `areset` signal.	10			ns
$t_{ARESET\_RECONFIG}$	Minimum pulse width on the `areset` signal when using PLL reconfiguration. Reset the PLL after `scandone` goes high.	500			ns

Notes to Table 5–92:
(1) Limited by I/O f_{MAX}. See Table 5–78 on page 5–69 for the maximum. Cannot exceed f_{OUT} specification.
(2) If the counter cascading feature of the PLL is utilized, there is no minimum output clock frequency.