Zynq-7000 EPP (XC7Z010 and XC7Z020): DC and AC Switching Characteristics

DS187 (v1.1) June 27, 2012 **Advance Product Specification**

Introduction

Zynq™-7000 EPPs are available in -3, -2, and -1 speed grades, with -3 having the highest performance. Zynq-7000 EPPs DC and AC characteristics are specified in commercial, extended, expanded, and industrial temperature ranges. Except the operating temperature range or unless otherwise noted, all the DC and AC electrical parameters are the same for a particular speed grade (that is, the timing characteristics of a -1 speed grade industrial device are the same as for a -1 speed grade commercial device). However, only selected speed grades and/or devices are available in the extended or industrial temperature range.

All specifications are representative of worst-case supply voltage and junction temperature conditions. The parameters included are common to popular designs and typical applications.

This Zynq-7000 EPP (XC7Z010 and XC7Z020) data sheet, part of an overall set of documentation on the Zynq-7000 EPPs, is available on the Xilinx website at www.xilinx.com/zynq. All specifications are subject to change without notice.

DC Characteristics

Table 1: **Absolute Maximum Ratings[1]**

Symbol	Description	Min	Max	Units
Processing System (PS)				
V_{CCPINT}	PS internal logic supply	–0.5	1.1	V
V_{CCPAUX}	PS auxiliary supply voltage	–0.5	2.0	V
V_{CCPLL}	PS PLL supply	–0.5	2.0	V
V_{CCO_DDR}	PS DDR I/O supply voltage	–0.5	2.0	V
V_{CCO_MIO}[2]	PS MIO I/O supply voltage	–0.5	3.6	V
V_{PREF}	Input reference voltage	–0.5	2.0	V
V_{PIN}[3][4][5]	PS DDR and MIO I/O input voltage	–0.5	V_{CCO} + 0.5	V
	PS DDR and MIO I/O input voltage for V_{REF} and differential I/O standards	–0.5	2.625	V
Programmable Logic (PL)				
V_{CCINT}	PL internal supply voltage	–0.5	1.1	V
V_{CCAUX}	PL auxiliary supply voltage	–0.5	2.0	V
V_{CCBRAM}	PL supply voltage for the block RAM memories	–0.5	1.1	V
V_{CCO}	PL supply voltage for 3.3V HR I/O banks	–0.5	3.6	V
V_{REF}	Input reference voltage	–0.5	2.0	V
V_{IN}[3][4][5]	I/O input voltage	–0.5	V_{CCO} + 0.5	V
	I/O input voltage for V_{REF} and differential I/O standards	–0.5	2.625	V
V_{CCBATT}	Key memory battery backup supply	–0.5	2.0	V

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Table 1: **Absolute Maximum Ratings[1] *(Cont'd)***

Symbol	Description	Min	Max	Units
XADC				
V_{CCADC}	XADC supply relative to GNDADC	–0.5	2.0	V
V_{REFP}	XADC reference input relative to GNDADC	–0.5	2.0	V
Temperature				
T_{STG}	Storage temperature (ambient)	–65	150	°C
T_{SOL}	Maximum soldering temperature for Pb/Sn component bodies[6]		+220	°C
	Maximum soldering temperature for Pb-free component bodies[6]		+260	°C
T_j	Maximum junction temperature[6]		+125	°C

Notes:

1. Stresses beyond those listed under Absolute Maximum Ratings might cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those listed under Operating Conditions is not implied. Exposure to Absolute Maximum Ratings conditions for extended periods of time might affect device reliability.
2. Applies to both MIO supply banks V_{CCO_MIO0} and V_{CCO_MIO1}.
3. The smaller absolute voltage specification always applies.
4. For I/O operation, refer to UG471, *7 Series FPGAs SelectIO Resources User Guide* or UG585, *Zynq-7000 Extensible Processing Platform Technical Reference Manual*.
5. The maximum limit applies to DC and AC signals.
6. For soldering guidelines and thermal considerations, see UG865, *Zynq-7000 EPP Packaging and Pinout Specification*.

Table 2: **Recommended Operating Conditions[1]**

Symbol	Description	Min	Typ	Max	Units
PS					
V_{CCPINT}	PS internal supply voltage	0.95	1.00	1.05	V
V_{CCPAUX}	PS auxiliary supply voltage	1.71	1.80	1.89	V
V_{CCPLL}	PS PLL supply	1.71	1.80	1.89	V
V_{CCO_DDR}	PS DDR I/O supply voltage	1.14		1.89	V
V_{CCO_MIO}[2]	PS MIO I/O supply voltage for MIO banks	1.71	–	3.465	V
V_{PIN}[3]	PS DDR and MIO I/O input voltage	–0.20	–	V_{CCO} + 0.20	V
	PS DDR and MIO I/O input voltage for V_{REF} and differential I/O standards	–0.20	–	2.625	V
PL					
V_{CCINT}	PL internal supply voltage	0.95	1.00	1.05	V
V_{CCAUX}	PL auxiliary supply voltage	1.71	1.80	1.89	V
V_{CCBRAM}	PL block RAM supply voltage	0.95	1.00	1.05	V
V_{CCO}[4][5]	PL supply voltage for 3.3V HR I/O banks	1.14	–	3.465	V
V_{IN}[3]	I/O input voltage	–0.20	–	V_{CCO} + 0.20	V
	I/O input voltage for V_{REF} and differential I/O standards	–0.20	–	2.625	V
I_{IN}[6]	Maximum current through any pin in a powered or unpowered bank when forward biasing the clamp diode	–	–	10	mA
V_{CCBATT}[7]	Battery voltage	1.0	–	1.89	V
XADC					
V_{CCADC}	XADC supply relative to GNDADC	1.71	1.80	1.89	V
V_{REFP}	Externally supplied reference voltage	1.20	1.25	1.30	V

Table 2: **Recommended Operating Conditions[1] *(Cont'd)***

Symbol	Description	Min	Typ	Max	Units
Temperature					
T_j	Junction temperature operating range for commercial (C) temperature devices	0	–	85	°C
	Junction temperature operating range for extended (E) temperature devices	0	–	100	°C
	Junction temperature operating range for industrial (I) temperature devices	–40	–	100	°C
	Junction temperature operating range for expanded (Q) temperature devices	–40	–	125	°C

Notes:

1. All voltages are relative to ground. The PL and PS share a common ground.
2. Applies to both MIO supply banks V_{CCO_MIO0} and V_{CCO_MIO1}.
3. The smaller absolute voltage specification always applies.
4. Configuration data is retained even if V_{CCO} drops to 0V.
5. Includes V_{CCO} of 1.2V, 1.5V, 1.8V, 2.5V, and 3.3V.
6. A total of 100 mA per PS or PL bank should not be exceeded.
7. V_{CCBATT} is required only when using bitstream encryption. If battery is not used, connect V_{CCBATT} to either ground or V_{CCAUX}.

Table 3: **DC Characteristics Over Recommended Operating Conditions**

Symbol	Description	Min	Typ[1]	Max	Units
V_{DRINT}	Data retention V_{CCINT} voltage (below which configuration data might be lost)	0.75	–	–	V
V_{DRI}	Data retention V_{CCAUX} voltage (below which configuration data might be lost)	1.5	–	–	V
I_{REF}	V_{REF} leakage current per pin		15		µA
I_L	Input or output leakage current per pin (sample-tested)		15		µA
C_{IN}[2]	Die input capacitance at the pad		8		pF
I_{RPU}	Pad pull-up (when selected) @ V_{IN} = 0V, V_{CCO} = 3.3V	90	–	330	µA
	Pad pull-up (when selected) @ V_{IN} = 0V, V_{CCO} = 2.5V	68	–	250	µA
	Pad pull-up (when selected) @ V_{IN} = 0V, V_{CCO} = 1.8V	34	–	220	µA
	Pad pull-up (when selected) @ V_{IN} = 0V, V_{CCO} = 1.5V	23	–	150	µA
	Pad pull-up (when selected) @ V_{IN} = 0V, V_{CCO} = 1.2V	12	–	120	µA
I_{RPD}[3]	Pad pull-down (when selected) @ V_{IN} = 3.3V	68	–	330	µA
	Pad pull-down (when selected) @ V_{IN} = 1.8V	45	–	180	µA
I_{CCADC}	Analog supply current, analog circuits in powered up state	–	–	25	mA
I_{BATT}[4]	Battery supply current	–	–	150	nA
R_{IN_TERM}[5]	Thevenin equivalent resistance of programmable input termination to $V_{CCO}/2$ (UNTUNED_SPLIT_40) for commercial (C), industrial (I), extended (E), and expanded (Q) temperature devices.	28	40	55	Ω
	Thevenin equivalent resistance of programmable input termination to $V_{CCO}/2$ (UNTUNED_SPLIT_50) for commercial (C), industrial (I), extended (E), and expanded (Q) temperature devices.	35	50	65	Ω
	Thevenin equivalent resistance of programmable input termination to $V_{CCO}/2$ (UNTUNED_SPLIT_60) for commercial (C), industrial (I), extended (E), and expanded (Q) temperature devices.	44	60	83	Ω

Table 3: **DC Characteristics Over Recommended Operating Conditions *(Cont'd)***

Symbol	Description	Min	Typ[(1)]	Max	Units
n	Temperature diode ideality factor		1.0002		n
r	Temperature diode series resistance		2		Ω

Notes:

1. Typical values are specified at nominal voltage, 25°C.
2. This measurement represents the die capacitance at the pad, not including the package.
3. The PS MIO pins do not have pull-down resistors.
4. Maximum value specified for worst case process at 25°C.
5. Termination resistance to a $V_{CCO}/2$ level.

Table 4: **Typical Quiescent Supply Current**

Symbol	Description	Device	Speed and Temperature Grade			Units
			-3	-2	-1	
$I_{CCPINTQ}$	PS quiescent V_{CCPINT} supply current	XC7Z010		152	152	mA
		XC7Z020		152	152	mA
$I_{CCPAUXQ}$	PS quiescent V_{CCPAUX} supply current	XC7Z010		13	13	mA
		XC7Z020		13	13	mA
I_{CCDDRQ}	PS quiescent V_{CCO_DDR} supply current	XC7Z010		2	2	mA
		XC7Z020		2	2	mA
I_{CCINTQ}	PL quiescent V_{CCINT} supply current	XC7Z010		49	49	mA
		XC7Z020		112	112	mA
I_{CCAUXQ}	PL quiescent V_{CCAUX} supply current	XC7Z010		10	10	mA
		XC7Z020		21	21	mA
I_{CCOQ}	PL quiescent V_{CCO} supply current	XC7Z010		1	1	mA
		XC7Z020		1	1	mA
$I_{CCBRAMQ}$	PL quiescent V_{CCBRAM} supply current	XC7Z010		3	3	mA
		XC7Z020		6	6	mA

Notes:

1. Typical values are specified at nominal voltage, 85°C junction temperatures (T_j) with single-ended SelectIO resources.
2. Typical values are for blank configured devices with no output current loads, no active input pull-up resistors, all I/O pins are 3-state and floating.
3. Use the XPower™ Estimator (XPE) spreadsheet tool (download at http://www.xilinx.com/power) to calculate static power consumption for conditions other than those specified.

Power Supply and PS Reset Requirements

Table 5 shows the minimum current, in addition to I_{CCQ}, that is required by Zynq-7000 devices for proper power-on and configuration. If the current minimums shown in Table 4 and Table 5 are met, the device powers on after all three supplies have passed through their power-on reset threshold voltages. Once initialized and configured, use the XPOWER tools to estimate current drain on these supplies.

Table 5: **Power-On Current for Zynq-7000 Devices[(1)]**

Device	$I_{CCPINTMIN}$	$I_{CCPAUXMIN}$	$I_{CCDDRMIN}$	$I_{CCINTMIN}$	$I_{CCAUXMIN}$	I_{CCOMIN}	$I_{CCBRAMMIN}$	Units
	Typ[(2)]	Typ[(2)]	Typ[(2)]	Typ[(2)]	Typ[(2)]	Typ[(2)]	Typ[(2)]	
XC7Z010								mA
XC7Z020	$I_{CCPINTQ}$ + 70	$I_{CCPAUXQ}$ + 40	$I_{CCPDDRQ}$ + 90	I_{CCINTQ} + 70	I_{CCAUXQ} + 40		$I_{CCBRAMQ}$ + 40	mA

Notes:

1. Use the XPOWER™ Estimator (XPE) spreadsheet tool (download at http://www.xilinx.com/power) to calculate maximum power-on currents.
2. Typical values are specified at nominal voltage, 25°C.

Table 6: **Power Supply Ramp Time**

Symbol	Description	Conditions	Min	Max	Units
V_{CCPINT}	PS internal supply voltage relative to GND		0.2	50	ms
V_{CCPAUX}	PS auxiliary supply voltage relative to GND		0.2	50	ms
V_{CCO_DDR}	PS DDR supply voltage relative to GND		0.2	50	ms
V_{CCO_MIO}	PS MIO banks supply voltage relative to GND		0.2	50	ms
T_{VCCINT}	PL ramp time from GND to 90% of V_{CCINT}		0.2	50	ms
T_{VCCO}	PL ramp time from GND to 90% of V_{CCO}		0.2	50	ms
T_{VCCAUX}	PL ramp time from GND to 90% of V_{CCAUX}		0.2	50	ms
$T_{VCCBRAM}$	PL ramp time from GND to 90% of V_{CCBRAM}		0.2	50	ms
$T_{VCCO2VCCAUX}$	Allowed time per power cycle for $V_{CCO} - V_{CCAUX} > 2.625V$ and $V_{CCO_MIO} - V_{CCPAUX} > 2.625$	$T_j = 100°C$[(1)]	–	500	ms
		$T_j = 85°C$[(1)]	–	800	

Notes:

1. Based on 240,000 power cycles with nominal V_{CCO} of 3.3V or 36,500 power cycles with worst case V_{CCO} of 3.465V.

PS Power-On/Off Power Supply Requirements

The recommended power-on sequence is V_{CCPINT}, V_{CCPAUX} and V_{CCPLL} together, then the PS V_{CCO} supplies (V_{CCO_MIO0}, V_{CCO_MIO1}, and V_{CCO_DDR}) to achieve minimum current draw and ensure that the I/Os are 3-stated at power-on. The recommended power-off sequence is the reverse of the power-on sequence. If V_{CCPAUX}, V_{CCPLL} and the PS V_{CCO} supplies (V_{CCO_MIO0}, V_{CCO_MIO1}, and V_{CCO_DDR}) have the same recommended voltage levels, then they can be powered by the same supply and ramped simultaneously. Xilinx recommends powering V_{CCPLL} with the same supply as V_{CCPAUX}, with an optional ferrite bead filter.

For V_{CCO_MIO0} and V_{CCO_MIO1} voltages of 3.3V:

- The voltage difference between V_{CCO_MIO0} /V_{CCO_MIO1} and V_{CCPAUX} must not exceed 2.625V for longer than $T_{VCCO2VCCAUX}$ for each power-on/off cycle to maintain device reliability levels.
- The $T_{VCCO2VCCAUX}$ time can be allocated in any percentage between the power-on and power-off ramps.

PS Power-on Reset

The PS provides the power on reset bar (PS_POR_B) input signal which must be held Low until all PS power supplies are stable and within legal limits. Additionally, PS_POR_B must be held Low until PS_CLK is stable for 2,000 clocks.

PL Power-On/Off Power Supply Requirements

The recommended power-on sequence for the PL is V_{CCINT}, V_{CCBRAM}, V_{CCAUX}, and V_{CCO} to achieve minimum current draw and ensure that the I/Os are 3-stated at power-on. The recommended power-off sequence is the reverse of the power-on sequence. If V_{CCINT} and V_{CCBRAM} have the same recommended voltage levels then both can be powered by the same supply and ramped simultaneously. If V_{CCAUX} and V_{CCO} have the same recommended voltage levels then both can be powered by the same supply and ramped simultaneously.

For V_{CCO} voltages of 3.3V in HR I/O banks and configuration bank 0:

- The voltage difference between V_{CCO} and V_{CCAUX} must not exceed 2.625V for longer than $T_{VCCO2VCCAUX}$ for each power-on/off cycle to maintain device reliability levels.
- The $T_{VCCO2VCCAUX}$ time can be allocated in any percentage between the power-on and power-off ramps.

PS—PL Power Sequencing

The PS and PL power supplies are fully independent. There are no sequencing requirements for the PS (V_{CCPINT}, V_{CCPAUX}, V_{CCO_DDR}, V_{CCO_MIO0}, and V_{CCO_MIO1}) and PL (V_{CCINT}, V_{CCBRAM}, V_{CCAUX}, and V_{CCO}) power supplies.

DC Input and Output Levels

Values for V_{IL} and V_{IH} are recommended input voltages. Values for I_{OL} and I_{OH} are guaranteed over the recommended operating conditions at the V_{OL} and V_{OH} test points. Only selected standards are tested. These are chosen to ensure that all standards meet their specifications. The selected standards are tested at a minimum V_{CCO} with the respective V_{OL} and V_{OH} voltage levels shown. Other standards are sample tested.

Table 7: **PS Input and Output Levels**[1]

Bank	V_{CCO}	V_{IL}		V_{IH}		V_{OL}	V_{OH}	I_{OL}	I_{OH}
		V, Min	V, Max	V, Min	V, Max	V, Max	V, Min	mA	mA
MIO	1.8V[2]	–0.3	35% V_{CCO}	65% V_{CCO}	V_{CCO} + 0.3	0.45	V_{CCO} – 0.45	8	8
MIO	2.5V[3]	–0.3	0.7	1.7	V_{CCO} + 0.3	0.4	V_{CCO} – 0.4	8	8
MIO	3.3V[3]	–0.3	0.8	2.0	3.45	0.4	V_{CCO} – 0.4	8	8
DDR	1.8V	–0.3	V_{REF} – 0.1	V_{REF} + 0.1	V_{CCO} + 0.3	0.4	V_{CCO} – 0.4	8	8

Notes:

1. Tested according to relevant specifications.
2. With bank V_{MODE} pin connected to V_{CCO} for the bank.
3. With bank V_{MODE} pin connected to GND for the bank.

Table 8: **SelectIO DC Input and Output Levels(1)(2)**

I/O Standard	V_{IL}		V_{IH}		V_{OL}	V_{OH}	I_{OL}	I_{OH}
	V, Min	V, Max	V, Min	V, Max	V, Max	V, Min	mA	mA
HSTL_I	–0.300	V_{REF} – 0.100	V_{REF} + 0.100	V_{CCO} + 0.300	0.400	V_{CCO} – 0.400	8	–8
HSTL_I_12	–0.300	V_{REF} – 0.080	V_{REF} + 0.080	V_{CCO} + 0.300	25% V_{CCO}	75% V_{CCO}	6.3	6.3
HSTL_I_18	–0.300	V_{REF} – 0.100	V_{REF} + 0.100	V_{CCO} + 0.300	0.400	V_{CCO} – 0.400	8	–8
HSTL_II	–0.300	V_{REF} – 0.100	V_{REF} + 0.100	V_{CCO} + 0.300	0.400	V_{CCO} – 0.400	16	–16
HSTL_II_18	–0.300	V_{REF} – 0.100	V_{REF} + 0.100	V_{CCO} + 0.300	0.400	V_{CCO} – 0.400	16	–16
HSUL_12	–0.300	V_{REF} – 0.130	V_{REF} + 0.130	V_{CCO} + 0.300	20% V_{CCO}	80% V_{CCO}	0.1	–0.1
LVCMOS12	–0.300	35% V_{CCO}	65% V_{CCO}	V_{CCO} + 0.300	0.400	V_{CCO} – 0.400	Note 3	Note 3
LVCMOS15	–0.300	35% V_{CCO}	65% V_{CCO}	V_{CCO} + 0.300	25% V_{CCO}	75% V_{CCO}	Note 4	Note 4
LVCMOS18	–0.300	35% V_{CCO}	65% V_{CCO}	V_{CCO} + 0.300	0.450	V_{CCO} – 0.450	Note 5	Note 5
LVCMOS25	–0.300	0.7	1.700	V_{CCO} + 0.300	0.400	V_{CCO} – 0.400	Note 4	Note 4
LVCMOS33	–0.300	0.8	2.000	3.450	0.400	V_{CCO} – 0.400	Note 4	Note 4
LVTTL	–0.300	0.8	2.000	3.450	0.400	2.400	Note 5	Note 5
MOBILE_DDR	–0.300	20% V_{CCO}	80% V_{CCO}	V_{CCO} + 0.300	10% V_{CCO}	90% V_{CCO}	0.1	–0.1
PCI33_3	–0.500	30% V_{CCO}	50% V_{CCO}	V_{CCO} + 0.500	10% V_{CCO}	90% V_{CCO}	1.5	–0.5
SSTL12	–0.300	V_{REF} – 0.100	V_{REF} + 0.100	V_{CCO} + 0.300	V_{REF} – 0.150	V_{REF} + 0.150	14.25	–14.25
SSTL135	–0.300	V_{REF} – 0.090	V_{REF} + 0.090	V_{CCO} + 0.300	V_{REF} – 0.150	V_{REF} + 0.150	13.0	–13.0
SSTL135_R	–0.300	V_{REF} – 0.090	V_{REF} + 0.090	V_{CCO} + 0.300	V_{REF} – 0.150	V_{REF} + 0.150	8.9	–8.9
SSTL15	–0.300	V_{REF} – 0.100	V_{REF} + 0.100	V_{CCO} + 0.300	V_{TT} – 0.175	V_{TT} + 0.175	13.0	–13.0
SSTL15_R	–0.300	V_{REF} – 0.100	V_{REF} + 0.100	V_{CCO} + 0.300	V_{TT} – 0.175	V_{TT} + 0.175	8.9	–8.9
SSTL18_I	–0.300	V_{REF} – 0.125	V_{REF} + 0.125	V_{CCO} + 0.300	V_{TT} – 0.470	V_{TT} + 0.470	8	–8
SSTL18_II	–0.300	V_{REF} – 0.125	V_{REF} + 0.125	V_{CCO} + 0.300	V_{TT} – 0.600	V_{TT} + 0.600	13.4	–13.4

Notes:

1. Tested according to relevant specifications.
2. 3.3V and 2.5V standards are only supported in 3.3V I/O banks.
3. Supported drive strengths of 4, 8, or 12 mA in HR I/O banks.
4. Supported drive strengths of 4, 8, 12, or 16 mA in HR I/O banks.
5. Supported drive strengths of 4, 8, 12, 16, or 24 mA in HR I/O banks.
6. For detailed interface specific DC voltage levels, see UG471: *7 Series FPGAs SelectIO Resources User Guide*.

Table 9: **Differential SelectIO DC Input and Output Levels**

I/O Standard	V_{ICM}(1)			V_{ID}(2)			V_{OCM}(3)			V_{OD}(4)		
	V, Min	V, Typ	V, Max	V, Min	V, Typ	V, Max	V, Min	V, Typ	V, Max	V, Min	V, Typ	V, Max
MINI_LVDS_25	0.300	1.200	V_{CCAUX}	0.200	0.400	0.600	1.000	1.200	1.400	0.300	0.450	0.600
PPDS_25	0.200	0.900	V_{CCAUX}	0.100	0.250	0.400	0.500	0.950	1.400	0.100	0.250	0.400
RSDS_25	0.300	0.900	1.500	0.100	0.350	0.600	1.000	1.200	1.400	0.100	0.350	0.600
TMDS_33	2.700	2.965	3.230	0.150	0.675	1.200	V_{CCO}–0.405	V_{CCO}–0.300	V_{CCO}–0.190	0.400	0.600	0.800

Notes:

1. V_{ICM} is the input common mode voltage.
2. V_{ID} is the input differential voltage ($Q–\overline{Q}$).
3. V_{OCM} is the output common mode voltage.
4. V_{OD} is the output differential voltage ($Q–\overline{Q}$).

Table 10: **Complementary Differential SelectIO DC Input and Output Levels**

I/O Standard	V_{ICM}[1]			V_{ID}[2]			V_{OCM}[3]			V_{OD}[4]			V_{OL}[5]	V_{OH}[6]
	V, Min	V, Typ	V, Max	V, Min	V, Typ	V, Max	V, Min	V, Typ	V, Max	V, Min	V, Typ	V, Max	V, Max	V, Min
BLVDS_25		1.250		0.100				1.250					N/A	N/A
DIFF_HSTL_I		0.750		0.100				0.750					N/A	N/A
DIFF_HSTL_I_18		0.900		0.100				0.900					N/A	N/A
DIFF_HSTL_II		0.750		0.100				0.750					N/A	N/A
DIFF_HSTL_II_18		0.900		0.100				0.900					N/A	N/A
DIFF_HSUL_12		0.600		0.100				0.600					N/A	N/A
DIFF_MOBILE_DDR		0.900		0.100				0.900					N/A	N/A
DIFF_SSTL12		0.600		0.100				0.600						
DIFF_SSTL135		0.675		0.100				0.675					$(V_{CCO}/2) - 0.160$	$(V_{CCO}/2) + 0.160$
DIFF_SSTL15		0.750		0.100				0.750					$(V_{CCO}/2) - 0.175$	$(V_{CCO}/2) + 0.175$
DIFF_SSTL18_I		0.900		0.100				0.900					N/A	N/A
DIFF_SSTL18_II		0.900		0.100				0.900					N/A	N/A

Notes:

1. V_{ICM} is the input common mode voltage.
2. V_{ID} is the input differential voltage ($Q–\overline{Q}$).
3. V_{OCM} is the output common mode voltage.
4. V_{OD} is the output differential voltage ($Q–\overline{Q}$).
5. V_{OL} is the single-ended low-output voltage.
6. V_{OH} is the single-ended high-output voltage.

Table 11: **LVDS_25 DC Specifications[1]**

Symbol	DC Parameter	Conditions	Min	Typ	Max	Units
V_{CCO}	Supply voltage		2.38	2.5	2.63	V
V_{OH}	Output High voltage for Q and $\overline{Q}$	R_T = 100 Ω across Q and $\overline{Q}$ signals	–	–	1.675	V
V_{OL}	Output Low voltage for Q and $\overline{Q}$	R_T = 100 Ω across Q and $\overline{Q}$ signals	0.700	–	–	V
V_{ODIFF}	Differential output voltage ($Q – \overline{Q}$), Q = High ($\overline{Q} – Q$), $\overline{Q}$ = High	R_T = 100 Ω across Q and $\overline{Q}$ signals	247	350	600	mV
V_{OCM}	Output common-mode voltage	R_T = 100 Ω across Q and $\overline{Q}$ signals	1.00	1.25	1.425	V
V_{IDIFF}	Differential input voltage ($Q – \overline{Q}$), Q = High ($\overline{Q} – Q$), $\overline{Q}$ = High		100	350	600	mV
V_{ICM}	Input common-mode voltage		0.3	1.2	1.425	V

Notes:

1. For detailed interface specific DC voltage levels, see UG471: *7 Series FPGAs SelectIO Resources User Guide*.

AC Switching Characteristics

All values represented in this data sheet are based on the advance speed specifications in ISE® Design Suite 14.1 v1.01 for the -3, -2, and -1 speed grades.

Switching characteristics are specified on a per-speed-grade basis and can be designated as Advance, Preliminary, or Production. Each designation is defined as follows:

Advance Product Specification

These specifications are based on simulations only and are typically available soon after device design specifications are frozen. Although speed grades with this designation are considered relatively stable and conservative, some under-reporting might still occur.

Preliminary Product Specification

These specifications are based on complete ES (engineering sample) silicon characterization. Devices and speed grades with this designation are intended to give a better indication of the expected performance of production silicon. The probability of under-reporting delays is greatly reduced as compared to Advance data.

Production Product Specification

These specifications are released once enough production silicon of a particular device family member has been characterized to provide full correlation between specifications and devices over numerous production lots. There is no under-reporting of delays, and customers receive formal notification of any subsequent changes. Typically, the slowest speed grades transition to Production before faster speed grades.

Testing of AC Switching Characteristics

Internal timing parameters are derived from measuring internal test patterns. All AC switching characteristics are representative of worst-case supply voltage and junction temperature conditions.

For more specific, more precise, and worst-case guaranteed data, use the values reported by the static timing analyzer and back-annotate to the simulation net list. Unless otherwise noted, values apply to all Zynq-7000 devices.

Speed Grade Designations

Since individual family members are produced at different times, the migration from one category to another depends completely on the status of the fabrication process for each device. Table 12 correlates the current status of each Zynq-7000 device on a per speed grade basis.

Table 12: **Zynq-7000 Device Speed Grade Designations**

Device	Speed Grade Designations		
	Advance	Preliminary	Production
XC7Z010	-1, -2, -3		
XC7Z020	-1, -2, -3		

Production Silicon and ISE Design Suite Status

In some cases, a particular family member (and speed grade) is released to production before a speed specification is released with the correct label (Advance, Preliminary, Production). Any labeling discrepancies are corrected in subsequent speed specification releases.

Table 13 lists the production released Zynq-7000 device, speed grade, and the minimum corresponding supported speed specification version and ISE Design Suite version. The ISE Design Suite and speed specifications listed are the minimum releases required for production. All subsequent releases of these tools and speed specifications are valid.

Table 13: **Zynq-7000 Device Production ISE Design Suite and Speed Specification Release**

Device	Speed Grade Designations		
	-3	-2	-1
XC7Z010			
XC7Z020			

Notes:

1. Blank entries indicate a device and/or speed grade in advance or preliminary status.

PS Performance Characteristics

This section provides the performance characteristics of some common functions and designs implemented in the PS. The numbers reported here are worst-case values; they have all been fully characterized. These values are subject to the same guidelines as the AC Switching Characteristics, page 9.

Table 14: **CPU Performance**

Symbol	Description	Speed Grade			Units
		-3	-2	-1	
F_{CPUMAX}	Maximum CPU clock frequency	800	733	667	MHz
F_{CPU_3XMAX}	Maximum CPU_3X clock frequency	400	367	333	MHz
F_{CPU_2XMAX}	Maximum CPU_2X clock frequency	267	244	222	MHz
F_{CPU_1XMAX}	Maximum CPU_1X clock frequency	133	122	111	MHz
F_{DDRCLK_2XMAX}	Maximum DDR_2X clock frequency	444	391	355	MHz

Table 15: **PS DDR Maximum Interface Performance**

Symbol	Description	Speed Grade			Units
		-3	-2	-1	
$F_{DDR3MAX}$	DDR3	1066	1066	1066	Mb/s
$F_{DDR2MAX}$	DDR2	800	800	800	Mb/s
$F_{LPDDR2MAX}$	LPDDR2	800	800	800	Mb/s

PS Switching Characteristics

Table 16: **PS Reference Clock Switching Characteristics**

Symbol	Description	Min	Typ	Max	Units
$T_{JTPSREF}$	PS reference clock jitter tolerance				ps
$T_{DCPSREF}$	PS reference clock duty cycle	40		60	%
F_{PSREF}	PS reference clock	30		60	MHz

Table 17: **PS PLL Switching Characteristics**

Symbol	Description	Speed Grade			Units
		-3	-2	-1	
$T_{PSPLLLOCK}$	PLL maximum lock time	60	60	60	µs
$F_{PSPLLMAX}$	PLL maximum output frequency	2000		1600	MHz
$F_{PSPLLMIN}$	PLL minimum output frequency	780	780	780	MHz

Table 18: **PS Reset Requirements**

Symbol	Description	Speed Grade			Units
		-3	-2	-1	
$T_{PSPORMIN}$	Minimum reference clock cycles at power-on before deassertion of PS POR_B[(1)].	2000	2000	2000	Reference Clock Cycles
$T_{PSRSTMIN}$	Soft reset minimum assertion period.	2000	2000	2000	Reference Clock Cycles

Notes:

1. PS_POR_B needs to be asserted low until PS supply voltages reach minimum levels

Table 19: **PS Configuration Requirements**

Symbol	Description	Speed Grade			Units
		-3	-2	-1	
$T_{PSPORMODEMIN}$	Minimum reference clock cycles from PS POR_B pin deassertion to when the mode pins become invalid.	50	50	50	Reference Clock Cycles

Memory Interfaces

Figure 1 through Figure 4 show the timing parameters specified in Table 20.

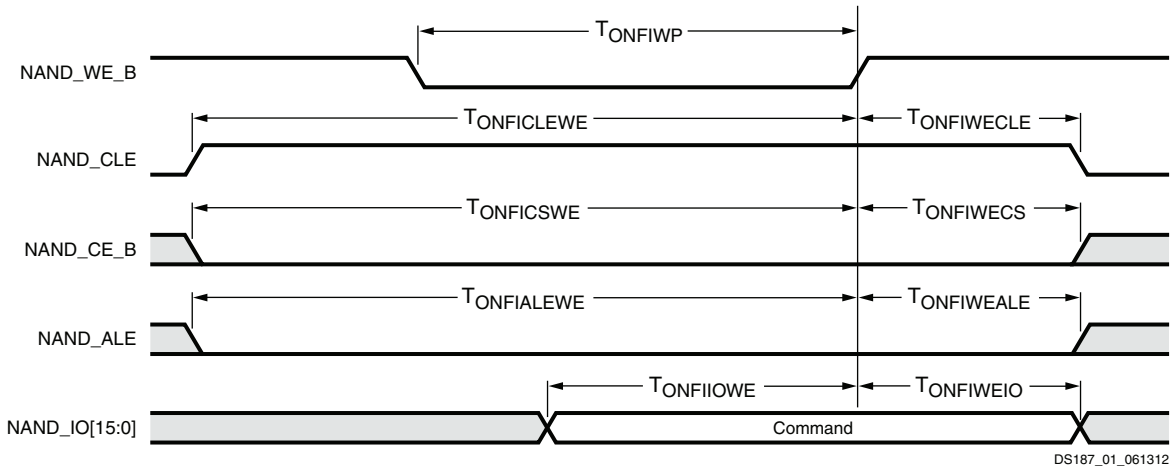

Figure 1: **Command Latch Timing Diagram**

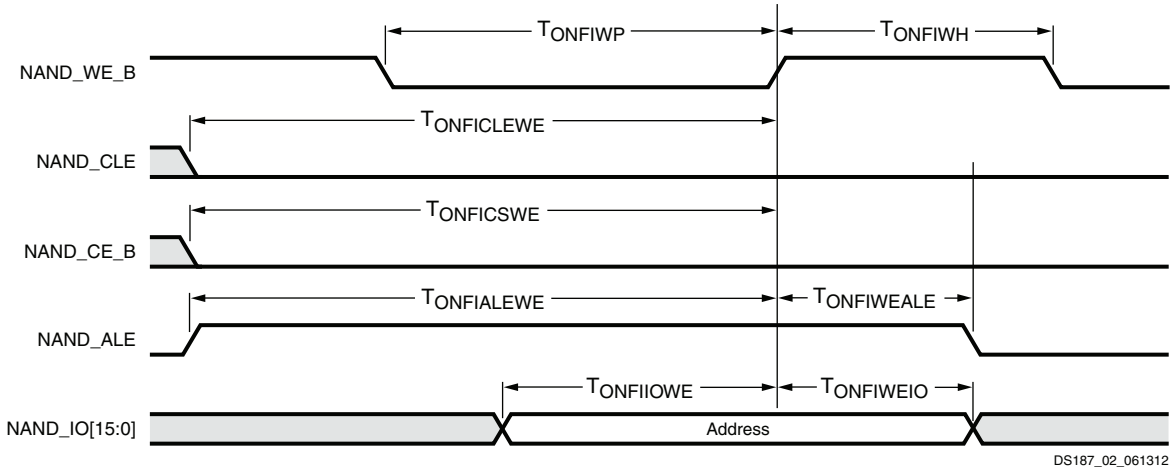

Figure 2: **Address Latch Timing Diagram**

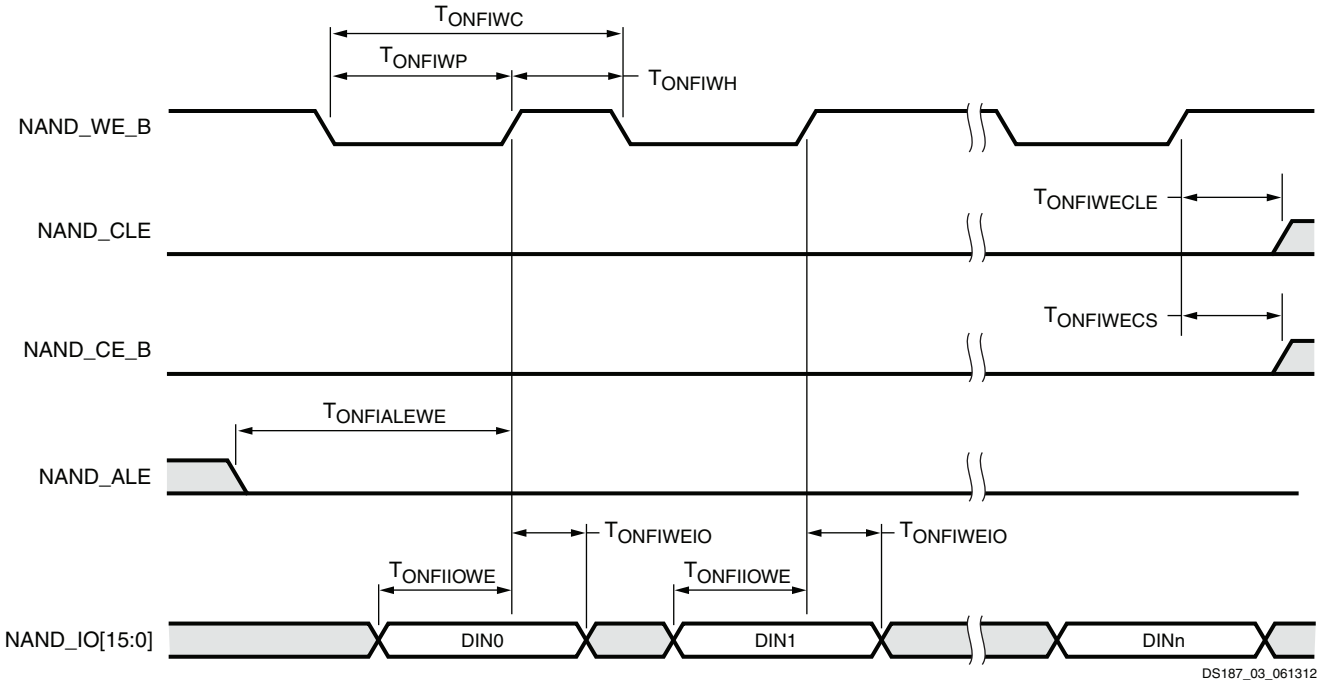

Figure 3: **Data Input Cycle Timing Diagram**

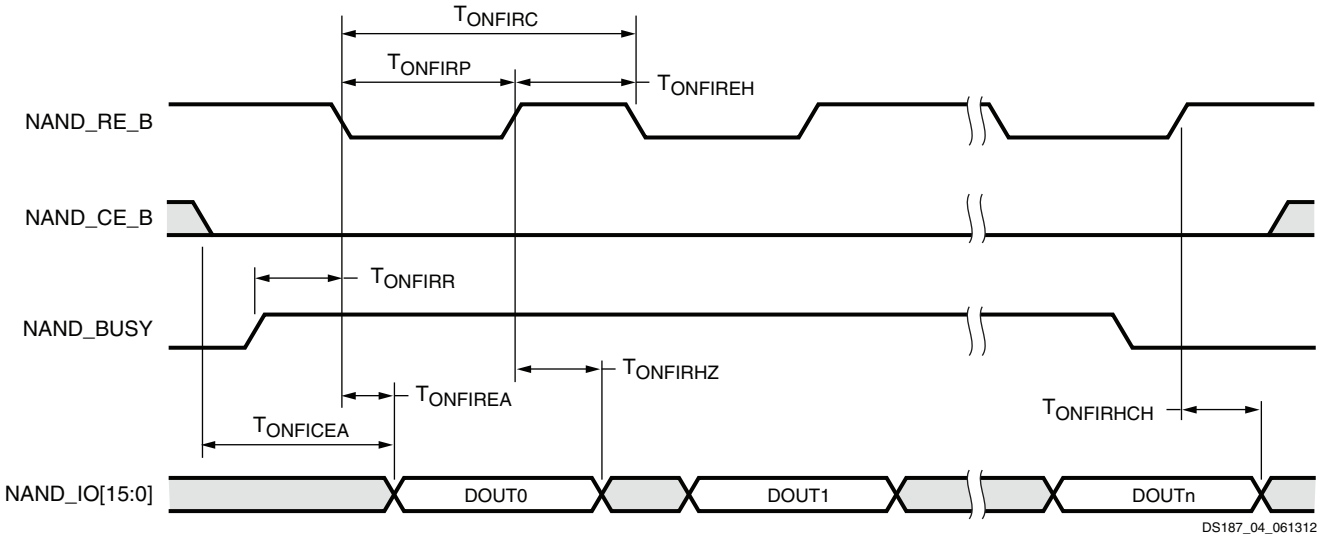

Figure 4: **Data Output Cycle Timing Diagram**

Table 20: **ONFI Interface Switching Characteristics**[(1)(2)(3)]

Symbol	Description	Min	Typ	Max	Units
$T_{ONFICLEWE}$	NAND_CLE setup time	10.0			ns
$T_{ONFIWECLE}$	NAND_CLE hold time	5.0			ns
$T_{ONFICSWE}$	NAND_CE_B setup time	15.0			ns
$T_{ONFIWECS}$	NAND_CE_B hold time	5.0			ns
T_{ONFIWP}	NAND_WE_B pulse width	10.0			ns
T_{ONFIWH}	NAND_WE_B high hold time	7.0			ns
$T_{ONFIALEWE}$	NAND_ALE setup time	10.0			ns

Table 20: **ONFI Interface Switching Characteristics[(1)(2)(3)] *(Cont'd)***

Symbol	Description	Min	Typ	Max	Units
$T_{ONFIWEALE}$	NAND_ALE hold time	5.0			ns
T_{ONFIRC}	Read cycle duration	20.0			ns
T_{ONFIRR}	Ready to NAND_RE_B Low	20.0			ns
$T_{ONFICEA}$	NAND_CE_B access time			25.0	ns
$T_{ONFIREA}$	NAND_RE_B access time			16.0	ns
$T_{ONFIRHZ}$	NAND_RE_B High to Hi-Z			100	ns
$T_{ONFIRHOH}$	NAND_RE_B High to output hold	15.0			ns
T_{ONFIWC}	Write cycle duration	20.0			ns
T_{ONFIRP}	NAND_RE_B pulse duration	10.0			ns
$T_{ONFIREH}$	NAND_RE_B high hold time	7.0			ns
$T_{ONFIIOWE}$	NAND_IO setup time	7.0			ns
$T_{ONFIWEIO}$	NAND_IO hold time	5.0			ns

Notes:

1. Refer to UG585: *Zynq-7000 Extensible Processing Platform Technical Reference Manual* for static memory controller programming information.
2. The static memory controller is compatible with the Open NAND Flash Interface Specification rev 1.0.
3. The static memory controller supports ONFI timing mode 5.

Table 21: **Parallel NOR FLASH/SRAM Interface Asynchronous Mode Switching Characteristics**

Symbol	Description	Min	Typ	Max	Units
T_{SRAMRC}	Read cycle duration	8		100	ns
T_{SRAMOE}	SRAM/NOR_OE pulse duration	4		25	ns
T_{SRAMWC}	Write cycle duration	8		100	ns
T_{SRAMWP}	SRAM/NOR_WE_B pulse duration	6.5		30	ns

Notes:

1. Refer to UG585: *Zynq-7000 Extensible Processing Platform Technical Reference Manual* for static memory controller programming information.

Table 22: **Quad-SPI Interface Switching Characteristics (Feedback Clock Enabled)**

Symbol	Description	Min	Typ	Max	Units
$T_{QSPISSCKQ1}$	Slave select output delay			3.0	ns
$T_{QSPICKQ1}$	Data output delay			3.0	ns
$T_{QSPIDCK1}$	Input data setup time	1.5			ns
$T_{QSPICKD1}$	Input data hold time	1.0			ns
$T_{DCQSPICLK1}$	Quad-SPI clock duty cycle	40		60	%
$F_{QSPICLK1}$	Quad-SPI clock frequency			100[(1)]	MHz

Notes:

1. Single and dual stacked Quad-SPI memory configurations only.

Table 23: **Quad-SPI Interface Switching Characteristics (Feedback Clock Disabled)**

Symbol	Description	Min	Typ	Max	Units
$T_{QSPISSCKQ2}$	Slave select output delay			3.0	ns
$T_{QSPICKQ2}$	Data output delay			3.0	ns
$T_{QSPIDCK2}$	Input data setup time	8.9			ns
$T_{QSPICKD2}$	Input data hold time	1.1			ns
$T_{DCQSPICLK2}$	Quad-SPI clock duty cycle	40		60	%
$F_{QSPICLK2}$	Quad-SPI clock frequency			40[(1)]	MHz

Notes:

1. Single and dual stacked Quad-SPI memory configurations only.

I/O Peripherals

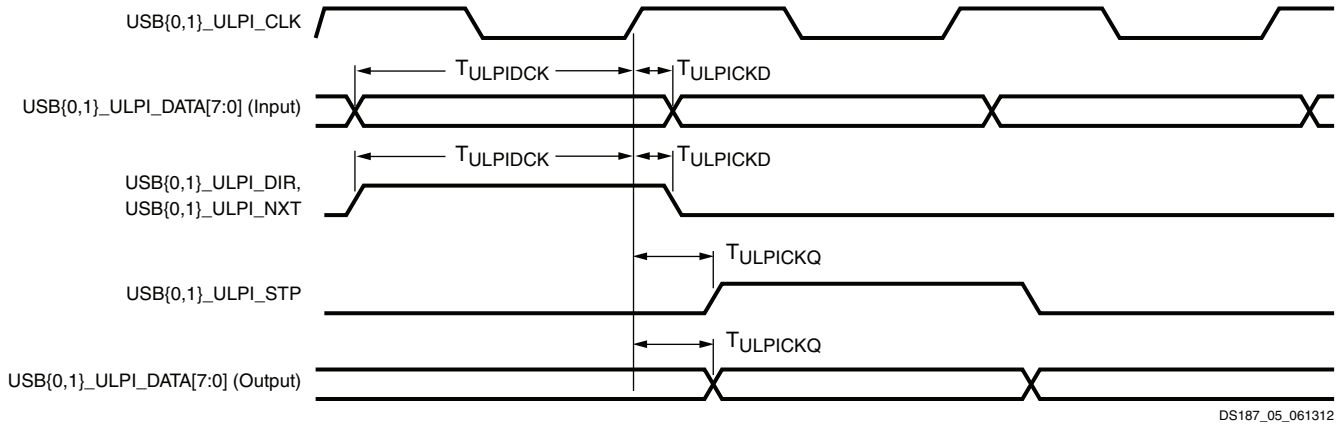

Figure 5: **ULPI Interface Timing Diagram**

Table 24: **ULPI Interface Clock Receiving Mode Switching Characteristics**

Symbol	Description	Min	Typ	Max	Units
$T_{ULPIDCK}$	Input setup to ULPI clock, all inputs	10.67			ns
$T_{ULPICKD}$	Input hold to ULPI clock, all inputs	1.0			ns
$T_{ULPICKO}$	ULPI clock to output valid, all outputs			8.86	ns
$F_{ULPICLK}$	ULPI reference clock frequency	59.97		60.03	MHz

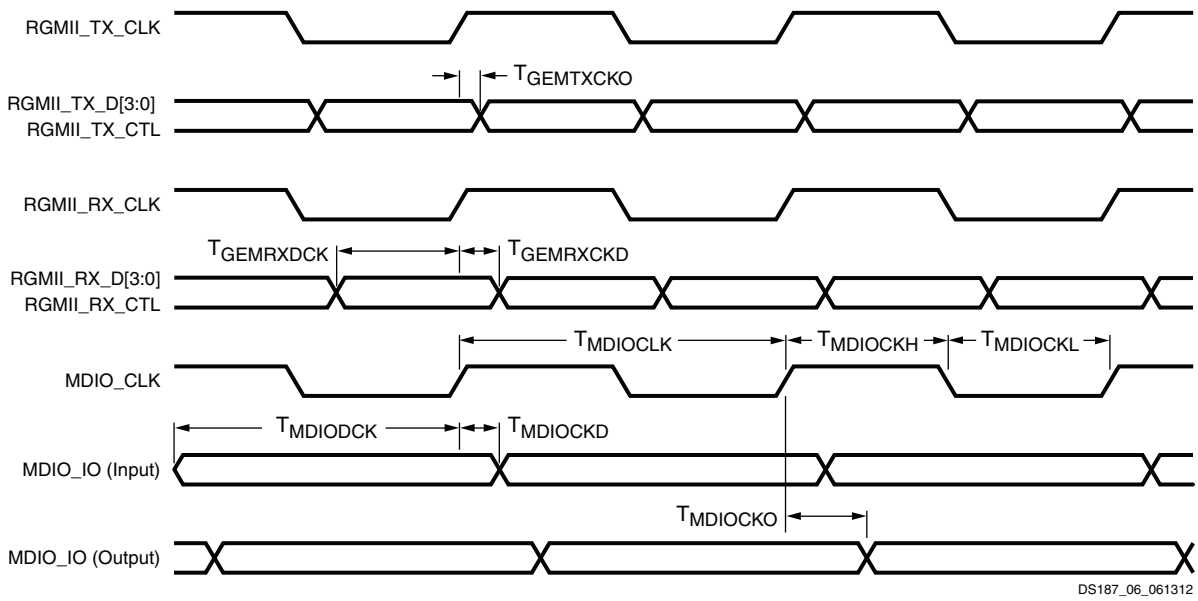

Figure 6: **RGMII Interface Timing Diagram**

Table 25: **RGMII Interface Switching Characteristics**[(1)(2)]

Symbol	Description	Min	Typ	Max	Units
$T_{DCGETXCLK}$	Transmit clock duty cycle	45		55	%
$T_{GEMTXCKO}$	RGMII_TX_D[3:0], RGMII_TX_CTL clock to out time	–0.5			ns
$T_{GEMRXDCK}$	RGMII_RX_D[3:0], RGMII_RX_CTL setup time	0.41			ns
$T_{GEMRXCKD}$	RGMII_RX_D[3:0], RGMII_RX_CTL hold time	0.45			ns
$T_{MDIOCLK}$	MDC output clock period	400			ns
$T_{MDIOCKH}$	MDC clock High time	160			ns
$T_{MDIOCKL}$	MDC clock Low time	160			ns
$T_{MDIODCK}$	MDIO input data setup time	100			ns
$T_{MDIOCKD}$	MDIO input data hold time	0			ns
$T_{MDIOCKO}$	MDIO data output delay			10	ns
$F_{GETXCLK}$	RGMII_TX_CLK transmit clock frequency		125		MHz
$F_{GERXCLK}$	RGMII_RX_CLK receive clock frequency		125		MHz

Notes:

1. The gigabit Ethernet MAC is compatible with the IEEE 802.3 standard.
2. Values in this table are specified during 1000 Mb/s operation.

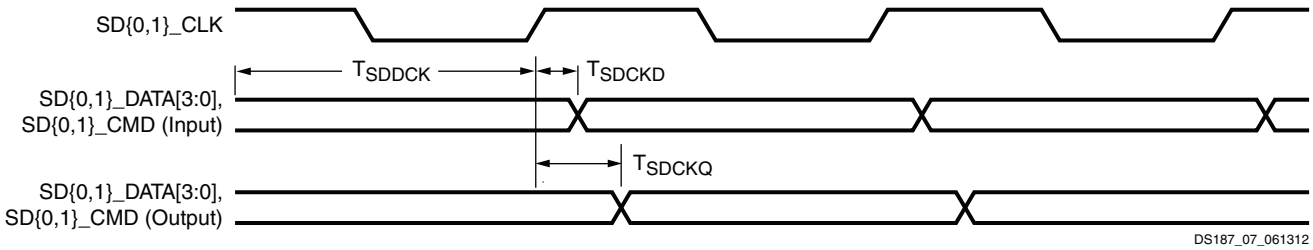

Figure 7: **SD/SDIO Interface Timing Diagram**

Table 26: **SD/SDIO Interface Full/High Speed Mode Switching Characteristics(1)**

Symbol	Description	Min	Typ	Max	Units
$T_{DCSDCLK}$	SDIO clock duty cycle				%
T_{SDCKO}	SD clock to out time, all outputs			12	ns
T_{SDDCK}	Input setup time to SD clock, all inputs	3			ns
T_{SDCKD}	Input hold time to SD clock, all inputs	1.05			ns
F_{SDCLK}	SDIO clock frequency	25		50	MHz

Notes:

1. The SD/SDIO peripheral interface is compliant with the standard SD host controller specification version 2.0 Part A2 standard.

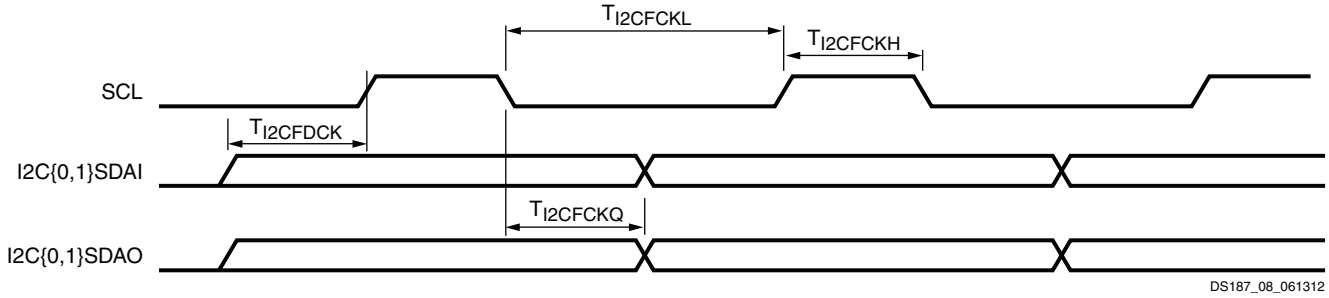

Figure 8: **I2C Fast Mode Interface Timing Diagram**

Table 27: **I2C Fast Mode Interface Switching Characteristics(1)**

Symbol	Description	Min	Typ	Max	Units
$T_{I2CFCKL}$	I2C{0,1}SCL Low time	1.3			µs
$T_{I2CFCKH}$	I2C{0,1}SCL High time	0.6			µs
$T_{I2CFCKO}$	I2C{0,1}SDAO clock to out delay			0.9	ns
$T_{I2CFDCK}$	I2C{0,1}SDAI setup time	100			ns
$F_{I2CFCLK}$	I2C{0,1}SCL clock frequency	0		400	KHz

Notes:

1. The I2C peripheral interface is compliant with the I2C-bus specification 2.

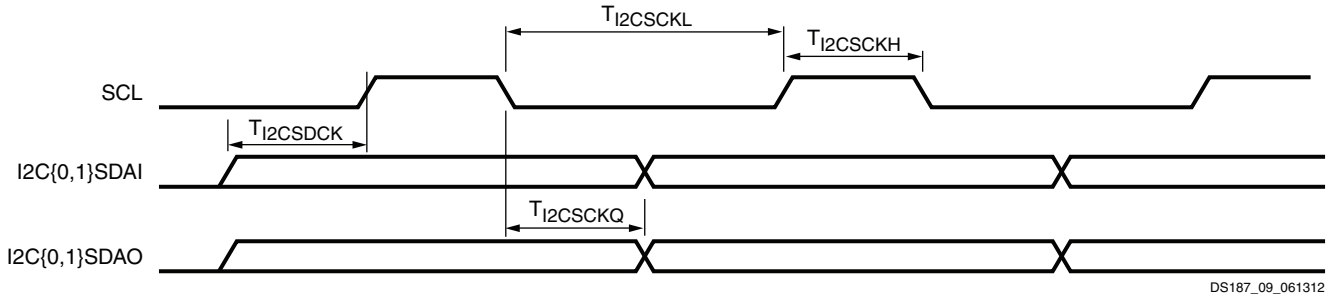

Figure 9: **I2C Standard Mode Interface Timing Diagram**

Table 28: **I2C Standard Mode Interface Switching Characteristics**

Symbol	Description	Min	Typ	Max	Units
$T_{I2CSCKL}$	I2C{0,1}SCL Low time	4.7			µs
$T_{I2CSCKH}$	I2C{0,1}SCL High time	4.0			µs
$T_{I2CSCKO}$	I2C{0,1}SDAO clock to out delay			3.45	ns
$T_{I2CSDCK}$	I2C{0,1}SDAI setup time	250			ns
$F_{I2CSCLK}$	I2C{0,1}SCL clock frequency	0		100	KHz

Notes:

1. The I2C peripheral interface is compliant with the I2C-bus specification 2.

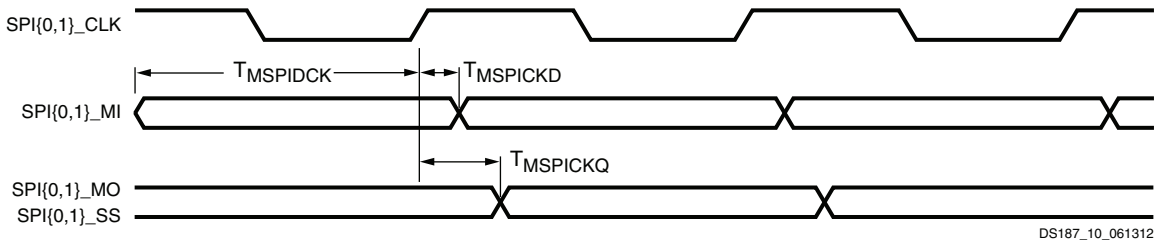

Figure 10: **SPI Master Mode Interface Timing Diagram**

Table 29: **SPI Master Mode Interface Switching Characteristics**[(1)]

Symbol	Description	Min	Typ	Max	Units
$T_{DCMSPICLK}$	SPI master mode clock duty cycle				%
$T_{MSPIDCK}$	Input setup time for MISO				ns
$T_{MSPICKD}$	Input hold time for MISO				ns
$T_{MSPICKO}$	Output delay for MOSI and SS{0,1,2}				ns
$F_{MSPICLK}$	SPI master mode clock frequency			50	MHz

Notes:

1. These parameters apply to all SPI controllers in the PS.

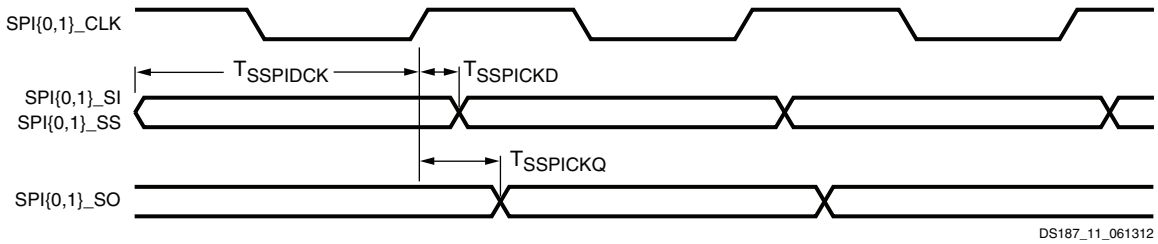

Figure 11: **SPI Slave Mode Interface Timing Diagram**

Table 30: **SPI Slave Mode Interface Switching Characteristics**[(1)]

Symbol	Description	Min	Typ	Max	Units
$T_{DCSSPICLK}$	SPI slave mode clock duty cycle				%
$T_{SSPIDCK}$	Input setup time for MOSI and SS				ns
$T_{SSPICKD}$	Input hold time for MOSI and SS				ns
$T_{SSPICKO}$	Output delay for MISO			15.2	ns
$F_{SSPICLK}$	SPI clock frequency			25	MHz

Notes:

1. These parameters apply to all SPI controllers in the PS.

Table 31: **CAN Interface Switching Characteristics**

Symbol	Description	Min	Typ	Max	Units
$T_{PWCANRX}$	Minimum receive pulse width	1	–	–	µs
$T_{PWCANTX}$	Minimum transmit pulse width	1	–	–	µs

Table 32: **UART Interface Switching Characteristics**

Symbol	Description	Min	Typ	Max	Units
$BAUD_{TXMAX}$	Maximum transmit baud rate	–	–	1	Mb/s
$BAUD_{RXMAX}$	Maximum receive baud rate	–	–	1	Mb/s

Table 33: **GPIO Banks Switching Characteristics**

Symbol	Description	Min	Typ	Max	Units
$T_{PWGPIOHL}$	Input low/high pulse width[(1)]	1			µs
SR_{GPIO}	Output slew rate				V/µs

Notes:

1. Pulse width requirement for interrupt.

Debug and Timer Interfaces

Table 34: **Trace Interface Switching Characteristics**

Symbol	Description	Min	Typ	Max	Units
T_{TCECKQ}	Trace databus output delay				ns
$T_{TCECTLCKQ}$	Trace port control output delay				ns
$T_{DCTCECLK}$	Trace clock duty cycle	40		60	%
F_{TCECLK}	Trace clock frequency			109	MHz

Table 35: **Triple Time Counter Interface Switching Characteristics**

Symbol	Description	Min	Typ	Max	Units
$T_{DCTTCOCLK}$	Triple time counter output clock duty cycle	40		60	%
$T_{DCTTCICLK}$	Triple time counter input clock duty cycle	40		60	%
$F_{TTCOCLK}$	Triple time counter output clock frequency				MHz
$F_{TTCICLK}$	Triple time counter input clock frequency				MHz

Table 36: **Watchdog Timer Interface Switching Characteristics**

Symbol	Description	Min	Typ	Max	Units
F_{WDTCLK}	Watchdog timer input clock frequency				MHz

PS-PL Interface

Table 37: **EMIO Ethernet Switching Characteristics**

Symbol	Description	Speed Grade			Units
		-3	-2	-1	
$T_{EMIOENETDCK}$	EMIO Ethernet signals minimum setup time, all inputs(1)	1.03	1.21	1.49	ns
$T_{EMIOENETCKD}$	EMIO Ethernet signals minimum hold time, all inputs(1)	0.00	0.00	0.00	ns
$T_{EMIOENETCKO}$	EMIO Ethernet signals maximum clock to out time, all outputs(2)	2.11	2.58	3.29	ns
$F_{EMIOGEMCLK}$	EMIO Ethernet maximum MAC frequency	125	125	125	MHz

Notes:
1. Reference to EMIOENET#GMIIRXCLK.
2. Reference to EMIOENET#GMIITXCLK.

Table 38: **EMIO SPI Switching Characteristics**

Symbol	Description	Speed Grade			Units
		-3	-2	-1	
$T_{EMIOSPIDCK}$	EMIO SPI signals minimum setup time, all inputs(1)				ns
$T_{EMIOSPIACKD}$	EMIO SPI signals minimum hold time, all inputs(1)				ns
$T_{EMIOSPICKQ}$	EMIO SPI signals maximum clock to out time, all outputs(1)				ns
$F_{EMIOSPICLK}$	EMIO SPI maximum frequency	25	25	25	MHz

Notes:
1. Reference to EMIOSPI#SCLK.

Table 39: **EMIO SD Switching Characteristics**

Symbol	Description	Speed Grade			Units
		-3	-2	-1	
$T_{EMIOSDDCK}$	EMIO SD signals minimum setup time, all inputs(1)	0.40	0.46	0.55	ns
$T_{EMIOSDACKD}$	EMIO SD signals minimum hold time, all inputs(1)	0.12	0.29	0.54	ns
$T_{EMIOSDCKQ}$	EMIO SD signals maximum clock to out time, all outputs(1)				ns
$F_{EMIOSDCLK}$	EMIO SD maximum frequency	25	25	25	MHz

Notes:
1. Reference to EMIOSDIO#CLKFB.

Table 40: **EMIO JTAG Switching Characteristics**

Symbol	Description	Speed Grade			Units
		-3	-2	-1	
$T_{EMIOJTAGDCK}$	EMIO JTAG signals minimum setup time, all inputs(1)	2.02	2.36	2.87	ns
$T_{EMIOJTAGCKD}$	EMIO JTAG signals minimum hold time, all inputs(1)	0.00	0.00	0.00	ns
$T_{EMIOJTAGCKO}$	EMIO JTAG signals maximum clock to out time, all outputs(1)	5.01	5.85	7.12	ns
$F_{EMIOJTAGCLK}$	EMIO JTAG maximum frequency	20	20	20	MHz

Notes:

1. Reference to EMIOPJTAGTCK.

Table 41: **EMIO Trace Packet Output Switching Characteristics**

Symbol	Description	Speed Grade			Units
		-3	-2	-1	
$T_{EMIOTRACECKO}$	EMIO trace maximum clock to out time, all outputs(1)	1.16	1.43	1.84	ns
$F_{EMIOTRACECLK}$	EMIO trace maximum frequency	125	125	125	MHz

Notes:

1. Reference to EMIOTRACECLK.

Table 42: **Fabric Trace Monitor Switching Characteristics**

Symbol	Description	Speed Grade			Units
		-3	-2	-1	
T_{FTMDCK}	Fabric trace monitor minimum setup time(1)	0.58	0.72	0.92	ns
T_{FTMCKD}	Fabric trace monitor minimum hold time(1)	0.00	0.00	0.02	ns
F_{FTMCLK}	Fabric trace monitor maximum frequency	125	125	125	MHz

Notes:

1. Reference to FTMDTRACEINCLOCK.

Table 43: **DMA Peripheral Request Interface Switching Characteristics**

Symbol	Description	Speed Grade			Units
		-3	-2	-1	
$T_{EMIODMADCK}$	DMA peripheral request interface signals setup time, all inputs(1)	0.42	0.55	0.74	ns
$T_{EMIODMACKD}$	DMA peripheral request interface signals hold time, all inputs(1)	0.00	0.02	0.14	ns
$T_{EMIODMACKO}$	DMA peripheral request interface signals minimum clock to out time, all outputs(1)	1.40	1.74	2.27	ns
$F_{EMIODMACLK}$	DMA maximum frequency	100	100	100	MHz

Notes:

1. Reference to DMA#ACLK.

AXI Interconnects

The typical clock frequencies for the AXI interconnects in Table 44 through Table 47 are based on a default system. The PL resources utilized in a system are:

- 70% LUT/flip-flop
- 70% block RAM
- 80% I/Os.

Table 44: **General Purpose Master AXI Interfaces Switching Characteristics**

Symbol	Description	Speed Grade			Units
		-3	-2	-1	
$T_{MAXIGPDCK}$	Master AXI general purpose port signals minimum setup time(1)	0.50	0.64	0.84	ns
$T_{MAXIGPCKD}$	Master AXI general purpose port signals minimum hold time(1)	0.00	0.10	0.26	ns
$T_{MAXIGPCKO}$	Master AXI general purpose port signals maximum clock to out time(1)	1.11	1.37	1.76	ns
$F_{MAXIGPCLK}$	Master AXI general purpose port typical frequency			150	MHz

Notes:

1. Reference to M_AXI_GP#_ACLK.

Table 45: **Slave AXI General Purpose Interfaces Switching Characteristics**

Symbol	Description	Speed Grade			Units
		-3	-2	-1	
$T_{SAXIGPDCK}$	Slave AXI general purpose port signals minimum setup time(1)	0.65	0.83	1.09	ns
$T_{SAXIGPCKD}$	Slave AXI general purpose port signals minimum hold time(1)	0.00	0.01	0.19	ns
$T_{SAXIGPCKO}$	Slave AXI general purpose port signals maximum clock to out time(1)	1.32	1.61	2.04	ns
$F_{SAXIGPCLK}$	Slave AXI general purpose port typical frequency			150	MHz

Notes:

1. Reference to S_AXI_GP#_ACLK.

Table 46: **Accelerator Coherency Port Slave AXI Interfaces Switching Characteristics**

Symbol	Description	Speed Grade			Units
		-3	-2	-1	
$T_{SAXIACPDCK}$	Slave ACP port signals minimum setup time(1)	0.57	0.68	0.85	ns
$T_{SAXIACPCKD}$	Slave ACP port signals minimum hold time(1)	0.00	0.07	0.27	ns
$T_{SAXIACPCKO}$	Slave ACP port signals maximum clock to out time(1)	1.10	1.37	1.79	ns
$F_{SAXIACPCLK}$	Slave ACP port typical frequency				MHz

Notes:

1. Reference to S_AXI_ACP_ACLK.

Table 47: **High-Performance Slave AXI Interfaces Switching Characteristics**

Symbol	Description	Speed Grade			Units
		-3	-2	-1	
$T_{SAXIHPDCK}$	Slave AXI high-performance port signals minimum setup time(1)	0.61	0.79	1.05	ns
$T_{SAXIHPCKD}$	Slave AXI high-performance port signals minimum hold time(1)	0.00	0.10	0.31	ns
$T_{SAXIHPCKO}$	Slave AXI high-performance port signals maximum clock to out time(1)	1.07	1.34	1.73	ns
$F_{SAXIHPCLK}$	Slave AXI high-performance port typical frequency			150	MHz

Notes:

1. Reference to S_AXI_HP#_ACLK.

PL Performance Characteristics

This section provides the performance characteristics of some common functions and designs implemented in the PL. The numbers reported here are worst-case values; they have all been fully characterized. These values are subject to the same guidelines as the AC Switching Characteristics, page 9.

Table 48: **PL Networking Applications Interface Performances**

Description	Speed Grade			Units
	-3	-2	-1	
SDR LVDS transmitter (using OSERDES; DATA_WIDTH = 4 to 8)	710	710	625	Mb/s
DDR LVDS transmitter (using OSERDES; DATA_WIDTH = 4 to 14)	1250	1250	950	Mb/s
SDR LVDS receiver (SFI-4.1)[1]	710	710	625	Mb/s
DDR LVDS receiver (SPI-4.2)[1]	1250	1250	950	Mb/s

Notes:

1. LVDS receivers are typically bounded with certain applications where specific dynamic phase-alignment (DPA) algorithms dominate deterministic performance.

Table 49: **PL Maximum Physical Interface (PHY) Rate for Memory Interfaces (CLG Packages)[1][2]**

Memory Standard	Speed Grade			Units
	-3	-2	-1	
DDR3	1066	800	800	Mb/s
DDR3L	800[3]	800	667	Mb/s
DDR2	800	800	667	Mb/s
LPDDR2	667	667	533	Mb/s

Notes:

1. V_{REF} tracking is required. For more information, see UG586, *7 Series FPGAs Memory Interface Solutions User Guide*.
2. When using the internal V_{REF}, the maximum data rate is 800 Mb/s (400 MHz).
3. The maximum PHY rate is 800 Mb/s in bank 13 of the XC7Z020 device.

PL Switching Characteristics

IOB Pad Input/Output/3-State

Table 50 summarizes the values of standard-specific data input delay adjustments, output delays terminating at pads (based on standard), and 3-state delays.

- T_{IOPI} is described as the delay from IOB pad through the input buffer to the I-pin of an IOB pad. The delay varies depending on the capability of the SelectIO input buffer.
- T_{IOOP} is described as the delay from the O pin to the IOB pad through the output buffer of an IOB pad. The delay varies depending on the capability of the SelectIO output buffer.
- T_{IOTP} is described as the delay from the T pin to the IOB pad through the output buffer of an IOB pad, when 3-state is disabled. The delay varies depending on the SelectIO capability of the output buffer. The DCI turn-on time is always faster than T_{IOTP} when the DCITERMDISABLE pin is used.

Table 50: **3.3V IOB High Range (HR) Switching Characteristics**

I/O Standard	T_{IOPI}			T_{IOOP}			T_{IOTP}			Units
	Speed Grade			Speed Grade			Speed Grade			
	-3	-2	-1	-3	-2	-1	-3	-2	-1	
LVTTL_S4	1.57	1.70	1.94	5.74	6.18	6.87	5.74	6.18	6.87	ns
LVTTL_S8	1.57	1.70	1.94	5.74	6.19	6.87	5.74	6.19	6.87	ns
LVTTL_S12	1.57	1.70	1.94	4.57	4.77	5.09	4.57	4.77	5.09	ns
LVTTL_S16	1.57	1.70	1.94	4.54	4.75	5.08	4.54	4.75	5.08	ns
LVTTL_S24	1.57	1.70	1.94	3.53	3.93	4.53	3.53	3.93	4.53	ns
LVTTL_F4	1.57	1.70	1.94	5.75	6.13	6.69	5.75	6.13	6.69	ns
LVTTL_F8	1.57	1.70	1.94	5.64	6.05	6.69	5.64	6.05	6.69	ns
LVTTL_F12	1.57	1.70	1.94	4.45	4.65	4.96	4.45	4.65	4.96	ns
LVTTL_F16	1.57	1.70	1.94	4.45	4.64	4.94	4.45	4.64	4.94	ns
LVTTL_F24	1.57	1.70	1.94	2.55	3.29	4.41	2.55	3.29	4.41	ns
LVDS_25	0.70	0.77	0.89	1.38	1.44	1.55	1.38	1.44	1.55	ns
MINI_LVDS_25	0.70	0.76	0.87	1.38	1.44	1.55	1.38	1.44	1.55	ns
BLVDS_25	0.70	0.77	0.91	1.91	2.07	2.32	1.91	2.07	2.32	ns
RSDS_25 (point to point)	0.70	0.77	0.89	1.38	1.44	1.55	1.38	1.44	1.55	ns
PPDS_25	0.73	0.79	0.91	1.35	1.44	1.58	1.35	1.44	1.58	ns
TMDS_33	0.84	0.92	1.07	1.45	1.51	1.62	1.45	1.51	1.62	ns
PCI33_3	1.54	1.68	1.92	2.94	3.22	3.66	2.94	3.22	3.66	ns
HSUL_12	0.65	0.69	0.77	2.31	2.60	3.04	2.31	2.60	3.04	ns
DIFF_HSUL_12	0.62	0.67	0.77	1.93	2.13	2.45	1.93	2.13	2.45	ns
HSTL_I_S	0.66	0.71	0.80	1.51	1.61	1.77	1.51	1.61	1.77	ns
HSTL_II_S	0.66	0.71	0.80	1.11	1.16	1.25	1.11	1.16	1.25	ns
HSTL_I_18_S	0.67	0.71	0.80	1.29	1.37	1.49	1.29	1.37	1.49	ns
HSTL_II_18_S	0.67	0.71	0.80	1.17	1.23	1.33	1.17	1.23	1.33	ns
DIFF_HSTL_I_S	0.70	0.75	0.84	1.40	1.48	1.61	1.40	1.48	1.61	ns
DIFF_HSTL_II_S	0.70	0.75	0.84	1.08	1.12	1.20	1.08	1.12	1.20	ns
DIFF_HSTL_I_18_S	0.72	0.77	0.87	1.23	1.29	1.40	1.23	1.29	1.40	ns
DIFF_HSTL_II_18_S	0.72	0.77	0.87	1.07	1.11	1.20	1.07	1.11	1.20	ns

Table 50: **3.3V IOB High Range (HR) Switching Characteristics *(Cont'd)***

I/O Standard	T_{IOPI}			T_{IOOP}			T_{IOTP}			Units
	Speed Grade			Speed Grade			Speed Grade			
	-3	-2	-1	-3	-2	-1	-3	-2	-1	
HSTL_I_F	0.66	0.71	0.80	1.07	1.13	1.24	1.07	1.13	1.24	ns
HSTL_II_F	0.66	0.71	0.80	0.97	1.02	1.11	0.97	1.02	1.11	ns
HSTL_I_18_F	0.67	0.71	0.80	1.05	1.10	1.21	1.05	1.10	1.21	ns
HSTL_II_18_F	0.67	0.71	0.80	0.97	1.02	1.12	0.97	1.02	1.12	ns
DIFF_HSTL_I_F	0.70	0.75	0.84	1.02	1.07	1.16	1.02	1.07	1.16	ns
DIFF_HSTL_II_F	0.70	0.75	0.84	0.94	0.99	1.08	0.94	0.99	1.08	ns
DIFF_HSTL_I_18_F	0.72	0.77	0.87	1.01	1.06	1.15	1.01	1.06	1.15	ns
DIFF_HSTL_II_18_F	0.72	0.77	0.87	0.93	0.98	1.07	0.93	0.98	1.07	ns
LVCMOS33_S4	1.78	1.90	2.12	5.65	6.03	6.60	5.65	6.03	6.60	ns
LVCMOS33_S8	1.78	1.90	2.12	4.79	5.21	5.86	4.79	5.21	5.86	ns
LVCMOS33_S12	1.78	1.90	2.12	3.86	4.23	4.80	3.86	4.23	4.80	ns
LVCMOS33_S16	1.78	1.90	2.12	3.30	3.66	4.21	3.30	3.66	4.21	ns
LVCMOS33_F4	1.78	1.90	2.12	5.04	5.32	5.76	5.04	5.32	5.76	ns
LVCMOS33_F8	1.78	1.90	2.12	4.29	4.55	4.97	4.29	4.55	4.97	ns
LVCMOS33_F12	1.78	1.90	2.12	2.72	3.39	4.42	2.72	3.39	4.42	ns
LVCMOS33_F16	1.78	1.90	2.12	2.59	2.82	3.19	2.59	2.82	3.19	ns
LVCMOS25_S4	1.49	1.58	1.76	4.95	5.41	6.11	4.95	5.41	6.11	ns
LVCMOS25_S8	1.49	1.58	1.76	3.88	4.29	4.92	3.88	4.29	4.92	ns
LVCMOS25_S12	1.49	1.58	1.76	3.07	3.59	4.40	3.07	3.59	4.40	ns
LVCMOS25_S16	1.49	1.58	1.76	3.52	3.93	4.55	3.52	3.93	4.55	ns
LVCMOS25_F4	1.49	1.58	1.76	4.69	5.02	5.54	4.69	5.02	5.54	ns
LVCMOS25_F8	1.49	1.58	1.76	2.73	3.25	4.05	2.73	3.25	4.05	ns
LVCMOS25_F12	1.49	1.58	1.76	2.72	3.24	4.04	2.72	3.24	4.04	ns
LVCMOS25_F16	1.49	1.58	1.76	2.17	2.48	2.97	2.17	2.48	2.97	ns
LVCMOS18_S4	0.78	0.82	0.92	3.72	3.90	4.19	3.72	3.90	4.19	ns
LVCMOS18_S8	0.78	0.82	0.92	2.91	3.23	3.74	2.91	3.23	3.74	ns
LVCMOS18_S12	0.78	0.82	0.92	2.91	3.23	3.74	2.91	3.23	3.74	ns
LVCMOS18_S16	0.78	0.82	0.92	2.01	2.22	2.56	2.01	2.22	2.56	ns
LVCMOS18_S24	0.78	0.82	0.92	1.87	2.03	2.28	1.87	2.03	2.28	ns
LVCMOS18_F4	0.78	0.82	0.92	3.58	3.71	3.93	3.58	3.71	3.93	ns
LVCMOS18_F8	0.78	0.82	0.92	2.11	2.42	2.89	2.11	2.42	2.89	ns
LVCMOS18_F12	0.78	0.82	0.92	2.11	2.42	2.89	2.11	2.42	2.89	ns
LVCMOS18_F16	0.78	0.82	0.92	1.59	1.73	1.96	1.59	1.73	1.96	ns
LVCMOS18_F24	0.78	0.82	0.92	1.34	1.44	1.60	1.34	1.44	1.60	ns
LVCMOS15_S4	0.80	0.86	0.97	4.14	4.36	4.71	4.14	4.36	4.71	ns
LVCMOS15_S8	0.80	0.86	0.97	2.50	2.81	3.29	2.50	2.81	3.29	ns
LVCMOS15_S12	0.80	0.86	0.97	2.00	2.19	2.50	2.00	2.19	2.50	ns
LVCMOS15_S16	0.80	0.86	0.97	1.90	2.07	2.35	1.90	2.07	2.35	ns

Table 50: **3.3V IOB High Range (HR) Switching Characteristics *(Cont'd)***

I/O Standard	T_{IOPI}			T_{IOOP}			T_{IOTP}			Units
	Speed Grade			Speed Grade			Speed Grade			
	-3	-2	-1	-3	-2	-1	-3	-2	-1	
LVCMOS15_F4	0.80	0.86	0.97	3.96	4.15	4.46	3.96	4.15	4.46	ns
LVCMOS15_F8	0.80	0.86	0.97	1.84	2.06	2.41	1.84	2.06	2.41	ns
LVCMOS15_F12	0.80	0.86	0.97	1.43	1.54	1.73	1.43	1.54	1.73	ns
LVCMOS15_F16	0.80	0.86	0.97	1.39	1.50	1.67	1.39	1.50	1.67	ns
LVCMOS12_S4	0.90	0.95	1.07	4.66	5.03	5.60	4.66	5.03	5.60	ns
LVCMOS12_S8	0.90	0.95	1.07	3.17	3.62	4.31	3.17	3.62	4.31	ns
LVCMOS12_S12	0.90	0.95	1.07	2.31	2.60	3.04	2.31	2.60	3.04	ns
LVCMOS12_F4	0.90	0.95	1.07	4.11	4.38	4.80	4.11	4.38	4.80	ns
LVCMOS12_F8	0.90	0.95	1.07	1.97	2.56	3.47	1.97	2.56	3.47	ns
LVCMOS12_F12	0.90	0.95	1.07	1.62	1.79	2.05	1.62	1.79	2.05	ns
SSTL135_S	0.66	0.69	0.77	1.10	1.15	1.25	1.10	1.15	1.25	ns
SSTL15_S	0.66	0.71	0.80	1.10	1.15	1.24	1.10	1.15	1.24	ns
SSTL18_I_S	0.67	0.71	0.80	1.55	1.65	1.82	1.55	1.65	1.82	ns
SSTL18_II_S	0.67	0.71	0.80	1.10	1.15	1.24	1.10	1.15	1.24	ns
DIFF_SSTL135_S	0.64	0.71	0.83	1.10	1.15	1.25	1.10	1.15	1.25	ns
DIFF_SSTL15_S	0.70	0.75	0.84	1.10	1.15	1.24	1.10	1.15	1.24	ns
DIFF_SSTL18_I_S	0.72	0.77	0.87	1.51	1.60	1.76	1.51	1.60	1.76	ns
DIFF_SSTL18_II_S	0.72	0.77	0.87	1.06	1.11	1.19	1.06	1.11	1.19	ns
SSTL135_F	0.66	0.69	0.77	0.98	1.03	1.13	0.98	1.03	1.13	ns
SSTL15_F	0.66	0.71	0.80	0.97	1.02	1.12	0.97	1.02	1.12	ns
SSTL18_I_F	0.67	0.71	0.80	1.07	1.13	1.23	1.07	1.13	1.23	ns
SSTL18_II_F	0.67	0.71	0.80	0.97	1.01	1.09	0.97	1.01	1.09	ns
DIFF_SSTL135_F	0.64	0.71	0.83	0.98	1.03	1.13	0.98	1.03	1.13	ns
DIFF_SSTL15_F	0.70	0.75	0.84	0.97	1.02	1.12	0.97	1.02	1.12	ns
DIFF_SSTL18_I_F	0.72	0.77	0.87	1.03	1.08	1.18	1.03	1.08	1.18	ns
DIFF_SSTL18_II_F	0.72	0.77	0.87	0.94	0.98	1.07	0.94	0.98	1.07	ns

Table 51 specifies the values of T_{IOTPHZ} and $T_{IOIBUFDISABLE}$. T_{IOTPHZ} is described as the delay from the T pin to the IOB pad through the output buffer of an IOB pad, when 3-state is enabled (i.e., a high impedance state). $T_{IOIBUFDISABLE}$ is described as the IOB delay from IBUFDISABLE to O output.

Table 51: **IOB 3-state ON Output Switching Characteristics (T_{IOTPHZ})**

Symbol	Description	Speed Grade			Units
		-3	-2	-1	
T_{IOTPHZ}	T input to pad high-impedance	2.06	2.19	2.37	ns
$T_{IOIBUFDISABLE}$	IBUF turn-on time from IBUFDISABLE to O output	2.11	2.30	2.60	ns

Input/Output Logic Switching Characteristics

Table 52: **ILOGIC Switching Characteristics**

Symbol	Description	Speed Grade			Units
		-3	-2	-1	
Setup and Hold					
T_{ICE1CK}/T_{ICKCE1}	CE1 pin setup/hold with respect to CLK	0.46/0.01	0.51/0.01	0.72/0.01	ns
T_{ISRCK}/T_{ICKSR}	SR pin setup/hold with respect to CLK	0.57/–0.15	0.66/–0.15	1.07/–0.15	ns
T_{IDOCK}/T_{IOCKD}	D pin setup/hold with respect to CLK without Delay	0.01/0.25	0.02/0.26	0.02/0.30	ns
T_{IDOCKD}/T_{IOCKDD}	DDLY pin setup/hold with respect to CLK (using IDELAY)	0.02/0.25	0.02/0.26	0.02/0.30	ns
Combinatorial					
T_{IDI}	D pin to O pin propagation delay, no Delay	0.10	0.11	0.13	ns
T_{IDID}	DDLY pin to O pin propagation delay (using IDELAY)	0.11	0.12	0.14	ns
Sequential Delays					
T_{IDLO}	D pin to Q1 pin using flip-flop as a latch without Delay	0.39	0.42	0.48	ns
T_{IDLOD}	DDLY pin to Q1 pin using flip-flop as a latch (using IDELAY)	0.39	0.42	0.49	ns
T_{ICKQ}	CLK to Q outputs	0.50	0.54	0.63	ns
T_{RQ_ILOGIC}	SR pin to OQ/TQ out	0.91	1.02	1.25	ns
T_{GSRQ_ILOGIC}	Global set/reset to Q outputs	7.60	7.60	10.51	ns
Set/Reset					
T_{RPW_ILOGIC}	Minimum pulse width, SR inputs	0.64	0.74	0.74	ns, Min

Table 53: **OLOGIC Switching Characteristics**

Symbol	Description	Speed Grade			Units
		-3	-2	-1	
Setup and Hold					
T_{ODCK}/T_{OCKD}	D1/D2 pins setup/hold with respect to CLK	0.64/–0.14	0.67/–0.14	0.80/–0.14	ns
T_{OOCECK}/T_{OCKOCE}	OCE pin setup/hold with respect to CLK	0.30/–0.08	0.32/–0.08	0.48/–0.08	ns
T_{OSRCK}/T_{OCKSR}	SR pin setup/hold with respect to CLK	0.35/0.12	0.41/0.12	0.76/0.12	ns
T_{OTCK}/T_{OCKT}	T1/T2 pins setup/hold with respect to CLK	0.65/–0.14	0.69/–0.14	0.84/–0.14	ns
T_{OTCECK}/T_{OCKTCE}	TCE pin setup/hold with respect to CLK	0.31/–0.08	0.32/–0.08	0.48/–0.08	ns
Combinatorial					
T_{ODQ}	D1 to OQ out or T1 to TQ out	0.79	0.87	1.05	ns
Sequential Delays					
T_{OCKQ}	CLK to OQ/TQ out	0.44	0.47	0.53	ns
T_{RQ_OLOGIC}	SR pin to OQ/TQ out	0.68	0.75	0.90	ns
T_{GSRQ_OLOGIC}	Global set/reset to Q outputs	7.60	7.60	10.51	ns
Set/Reset					
T_{RPW_OLOGIC}	Minimum pulse width, SR inputs	0.64	0.74	0.74	ns, Min

Input Serializer/Deserializer Switching Characteristics

Table 54: **ISERDES Switching Characteristics**

Symbol	Description	Speed Grade			Units
		-3	-2	-1	
Setup and Hold for Control Lines					
$T_{ISCCK_BITSLIP}$/ $T_{ISCKC_BITSLIP}$	BITSLIP pin setup/hold with respect to CLKDIV	0.01/0.13	0.02/0.14	0.02/0.17	ns
T_{ISCCK_CE} / T_{ISCKC_CE}[2]	CE pin setup/hold with respect to CLK (for CE1)	0.42/–0.02	0.48/–0.02	0.68/–0.02	ns
T_{ISCCK_CE2} / T_{ISCKC_CE2}[2]	CE pin setup/hold with respect to CLKDIV (for CE2)	–0.11/0.31	–0.11/0.34	–0.11/0.38	ns
Setup and Hold for Data Lines					
T_{ISDCK_D} /T_{ISCKD_D}	D pin setup/hold with respect to CLK	–0.02/0.12	–0.02/0.13	–0.02/0.16	ns
T_{ISDCK_DDLY} /T_{ISCKD_DDLY}	DDLY pin setup/hold with respect to CLK (using IDELAY)[1]	–0.02/0.11	–0.02/0.13	–0.02/0.16	ns
$T_{ISDCK_D_DDR}$ /$T_{ISCKD_D_DDR}$	D pin setup/hold with respect to CLK at DDR mode	–0.02/0.12	–0.02/0.13	–0.02/0.16	ns
$T_{ISDCK_DDLY_DDR}$/ $T_{ISCKD_DDLY_DDR}$	D pin setup/hold with respect to CLK at DDR mode (using IDELAY)[1]	0.11/0.11	0.13/0.13	0.16/0.16	ns
Sequential Delays					
T_{ISCKO_Q}	CLKDIV to out at Q pin	0.47	0.51	0.57	ns
Propagation Delays					
T_{ISDO_DO}	D input to DO output pin	0.19	0.20	0.23	ns

Notes:

1. Recorded at 0 tap value.
2. T_{ISCCK_CE2} and T_{ISCKC_CE2} are reported as T_{ISCCK_CE}/T_{ISCKC_CE} in TRACE report.

Output Serializer/Deserializer Switching Characteristics

Table 55: **OSERDES Switching Characteristics**

Symbol	Description	Speed Grade			Units
		-3	-2	-1	
Setup and Hold					
T_{OSDCK_D}/T_{OSCKD_D}	D input setup/hold with respect to CLKDIV	0.40/–0.05	0.43/–0.05	0.60/–0.05	ns
T_{OSDCK_T}/T_{OSCKD_T}[1]	T input setup/hold with respect to CLK	0.65/–0.14	0.69/–0.14	0.83/–0.14	ns
T_{OSDCK_T2}/T_{OSCKD_T2}[1]	T input setup/hold with respect to CLKDIV	0.29/–0.14	0.32/–0.14	0.37/–0.14	ns
T_{OSCCK_OCE}/T_{OSCKC_OCE}	OCE input setup/hold with respect to CLK	0.30/–0.02	0.32/–0.02	0.48/–0.02	ns
T_{OSCCK_S}	SR (reset) input setup with respect to CLKDIV	0.44	0.49	0.81	ns
T_{OSCCK_TCE}/T_{OSCKC_TCE}	TCE input setup/hold with respect to CLK	0.31/–0.08	0.32/–0.08	0.48/–0.08	ns
Sequential Delays					
T_{OSCKO_OQ}	Clock to out from CLK to OQ	0.38	0.40	0.45	ns
T_{OSCKO_TQ}	Clock to out from CLK to TQ	0.44	0.47	0.53	ns
Combinatorial					
T_{OSDO_TTQ}	T input to TQ out	0.79	0.87	1.05	ns

Notes:

1. T_{OSDCK_T2} and T_{OSCKD_T2} are reported as T_{OSDCK_T}/T_{OSCKD_T} in TRACE report.

Input Delay Switching Characteristics

Table 56: **Input Delay Switching Characteristics**

Symbol	Description	Speed Grade			Units
		-3	-2	-1	
IDELAYCTRL					
T_{DLYCCO_RDY}	Reset to ready for IDELAYCTRL	3.48	3.48	3.48	µs
$F_{IDELAYCTRL_REF}$	Attribute REFCLK frequency = 200.0[1]	200	200	200	MHz
	Attribute REFCLK frequency = 300.0[1]	300	300	N/A	MHz
IDELAYCTRL_REF_PRECISION	REFCLK precision	±10	±10	±10	MHz
$T_{IDELAYCTRL_RPW}$	Minimum reset pulse width	56.16	56.16	56.16	ns
IDELAY					
$T_{IDELAYRESOLUTION}$	IDELAY chain delay resolution	1/(32 x 2 x F_{REF})			ps
$T_{IDELAYPAT_JIT}$	Pattern dependent period jitter in delay chain for clock pattern.[2]	0	0	0	ps per tap
	Pattern dependent period jitter in delay chain for random data pattern (PRBS 23)[3]	±5	±5	±5	ps per tap
	Pattern dependent period jitter in delay chain for random data pattern (PRBS 23)[4]	±10	±10	±10	ps per tap
$T_{IDELAY_CLK_MAX}$	Maximum frequency of CLK input to IDELAY	680	680	680	MHz
T_{IDCCK_CE} / T_{IDCKC_CE}	CE pin setup/hold with respect to C for IDELAY	0.12/0.11	0.15/0.13	0.20/0.15	ns
T_{IDCCK_INC}/ T_{IDCKC_INC}	INC pin setup/hold with respect to C for IDELAY	0.11/0.15	0.13/0.17	0.15/0.21	ns
T_{IDCCK_RST}/ T_{IDCKC_RST}	RST pin setup/hold with respect to C for IDELAY	0.14/0.09	0.15/0.11	0.17/0.13	ns
$T_{IDDO_IDATAIN}$	Propagation delay through IDELAY	Note 5	Note 5	Note 5	ps

Notes:

1. Average tap delay at 200 MHz = 78 ps, at 300 MHz = 52 ps.
2. When HIGH_PERFORMANCE mode is set to TRUE or FALSE.
3. When HIGH_PERFORMANCE mode is set to TRUE.
4. When HIGH_PERFORMANCE mode is set to FALSE.
5. Delay depends on IDELAY tap setting. See TRACE report for actual values.

Table 57: **IO_FIFO Switching Characteristics**

Symbol	Description	Speed Grade			Units
		-3	-2	-1	
IO_FIFO Clock to Out Delays					
T_{OFFCKO_DO}	RDCLK to Q outputs	0.35	0.45	0.45	ns
T_{CKO_FLAGS}	Clock to IO_FIFO flags	0.44	0.58	0.58	ns
Setup and Hold					
T_{CCK_D}/T_{CKC_D}	D inputs to WRCLK	0.64/–0.09	0.80/–0.08	0.80/–0.08	ns
T_{IFFCCK_WREN} /T_{IFFCKC_WREN}	WREN to WRCLK	0.53/–0.07	0.69/–0.07	0.69/–0.07	ns
T_{OFFCCK_RDEN}/T_{OFFCKC_RDEN}	RDEN to RDCLK	0.63/–0.03	0.80/–0.03	0.80/–0.03	ns
Minimum Pulse Width					
$T_{PWH_IO_FIFO}$	RESET, RDCLK, WRCLK	1.62	2.15	2.15	ns
$T_{PWL_IO_FIFO}$	RESET, RDCLK, WRCLK	1.62	2.15	2.15	ns
Maximum Frequency					
F_{MAX}	RDCLK and WRCLK	266	200	200	MHz

CLB Switching Characteristics

Table 58: **CLB Switching Characteristics**

Symbol	Description	Speed Grade			Units
		-3	-2	-1	
Combinatorial Delays					
T_{ILO}	An – Dn LUT address to A	0.10	0.11	0.13	ns, Max
T_{ILO_2}	An – Dn LUT address to AMUX/CMUX	0.27	0.30	0.36	ns, Max
T_{ILO_3}	An – Dn LUT address to BMUX_A	0.42	0.46	0.55	ns, Max
T_{ITO}	An – Dn inputs to A – D Q outputs	0.94	1.05	1.27	ns, Max
T_{AXA}	AX inputs to AMUX output	0.62	0.69	0.84	ns, Max
T_{AXB}	AX inputs to BMUX output	0.58	0.66	0.83	ns, Max
T_{AXC}	AX inputs to CMUX output	0.60	0.68	0.82	ns, Max
T_{AXD}	AX inputs to DMUX output	0.68	0.75	0.90	ns, Max
T_{BXB}	BX inputs to BMUX output	0.51	0.57	0.69	ns, Max
T_{BXD}	BX inputs to DMUX output	0.62	0.69	0.82	ns, Max
T_{CXC}	CX inputs to CMUX output	0.42	0.48	0.58	ns, Max
T_{CXD}	CX inputs to DMUX output	0.53	0.59	0.71	ns, Max
T_{DXD}	DX inputs to DMUX output	0.52	0.58	0.70	ns, Max
Sequential Delays					
T_{CKO}	Clock to AQ – DQ outputs	0.40	0.44	0.53	ns, Max
T_{SHCKO}	Clock to AMUX – DMUX outputs	0.47	0.53	0.66	ns, Max
Setup and Hold Times of CLB Flip-Flops Before/After Clock CLK					
T_{AS}/T_{AH}	A_N – D_N input to CLK on A – D flip-flops	0.07/0.12	0.09/0.14	0.11/0.18	ns, Min
T_{DICK}/T_{CKDI}	A_X – D_X input to CLK on A – D flip-flops	0.06/0.19	0.07/0.21	0.09/0.26	ns, Min
	A_X – D_X input through MUXs and/or carry logic to CLK on A – D flip-flops	0.59/0.08	0.66/0.09	0.81/0.11	ns, Min
$T_{CECK_CLB}/T_{CKCE_CLB}$	CE input to CLK on A – D flip-flops	0.15/0.00	0.17/0.00	0.21/0.01	ns, Min
T_{SRCK}/T_{CKSR}	SR input to CLK on A – D flip-flops	0.38/0.03	0.43/0.04	0.53/0.05	ns, Min
Set/Reset					
T_{SRMIN}	SR input minimum pulse width	0.52	0.78	1.04	ns, Min
T_{RQ}	Delay from SR input to AQ – DQ flip-flops	0.53	0.59	0.71	ns, Max
T_{CEO}	Delay from CE input to AQ – DQ flip-flops	0.52	0.58	0.70	ns, Max
F_{TOG}	Toggle frequency (for export control)	1412	1286	1098	MHz

Notes:

1. A Zero “0” hold time listing indicates no hold time or a negative hold time.
2. These items are of interest for carry-chain applications.

CLB Distributed RAM Switching Characteristics (SLICEM Only)

Table 59: **CLB Distributed RAM Switching Characteristics**

Symbol	Description	Speed Grade			Units
		-3	-2	-1	
Sequential Delays					
T_{SHCKO}	Clock to A – B outputs	0.98	1.09	1.32	ns, Max
T_{SHCKO_1}	Clock to AMUX – BMUX outputs	1.37	1.53	1.86	ns, Max
Setup and Hold Times Before/After Clock CLK					
T_{DS_LRAM}/T_{DH_LRAM}	A – D inputs to CLK	0.54/0.28	0.60/0.30	0.72/0.35	ns, Min
T_{AS_LRAM}/T_{AH_LRAM}	Address An inputs to clock	0.27/0.55	0.30/0.60	0.37/0.70	ns, Min
	Address An inputs through MUXs and/or carry logic to clock	0.69/0.18	0.77/0.21	0.94/0.26	ns, Min
T_{WS_LRAM}/T_{WH_LRAM}	WE input to clock	0.38/0.10	0.43/0.10	0.53/0.12	ns, Min
$T_{CECK_LRAM}/T_{CKCE_LRAM}$	CE input to CLK	0.39/0.10	0.44/0.10	0.53/0.11	ns, Min
Clock CLK					
T_{MPW_LRAM}	Minimum pulse width	0.70	0.82	1.00	ns, Min
T_{MCP}	Minimum clock period	1.40	1.64	2.00	ns, Min

Notes:

1. A Zero “0” hold time listing indicates no hold time or a negative hold time.
2. T_{SHCKO} also represents the CLK to XMUX output. Refer to TRACE report for the CLK to XMUX path.

CLB Shift Register Switching Characteristics (SLICEM Only)

Table 60: **CLB Shift Register Switching Characteristics**

Symbol	Description	Speed Grade			Units
		-3	-2	-1	
Sequential Delays					
T_{REG}	Clock to A – D outputs	1.19	1.21	1.30	ns, Max
T_{REG_MUX}	Clock to AMUX – DMUX output	1.58	1.65	1.84	ns, Max
T_{REG_M31}	Clock to DMUX output via M31 output	1.09	1.14	1.27	ns, Max
Setup and Hold Times Before/After Clock CLK					
$T_{WS_SHFREG}/T_{WH_SHFREG}$	WE input	0.37/0.10	0.37/0.11	0.37/0.13	ns, Min
$T_{CECK_SHFREG}/T_{CKCE_SHFREG}$	CE input to CLK	0.37/0.10	0.37/0.11	0.37/0.13	ns, Min
$T_{DS_SHFREG}/T_{DH_SHFREG}$	A – D inputs to CLK	0.33/0.34	0.35/0.35	0.40/0.39	ns, Min
Clock CLK					
T_{MPW_SHFREG}	Minimum pulse width	0.60	0.70	0.85	ns, Min

Notes:

1. A Zero “0” hold time listing indicates no hold time or a negative hold time.

Block RAM and FIFO Switching Characteristics

Table 61: **Block RAM and FIFO Switching Characteristics**

Symbol	Description	Speed Grade			Units
		-3	-2	-1	
Block RAM and FIFO Clock to Out Delays					
T_{RCKO_DO} and $T_{RCKO_DO_REG}$[1]	Clock CLK to DOUT output (without output register)[2][3]	2.10	2.24	2.46	ns, Max
	Clock CLK to DOUT output (with output register)[4][5]	0.73	0.81	0.94	ns, Max
$T_{RCKO_DO_ECC}$ and $T_{RCKO_DO_ECC_REG}$	Clock CLK to DOUT output with ECC (without output register)[2][3]	2.77	3.20	3.84	ns, Max
	Clock CLK to DOUT output with ECC (with output register)[4][5]	0.73	0.81	0.94	ns, Max
$T_{RCKO_DO_CASCOUT}$ and $T_{RCKO_DO_CASCOUT_REG}$	Clock CLK to DOUT output with cascade (without output register)[2]	2.61	2.88	3.30	ns, Max
	Clock CLK to DOUT output with cascade (with output register)[4]	1.16	1.28	1.46	ns, Max
T_{RCKO_FLAGS}	Clock CLK to FIFO flags outputs[6]	0.76	0.87	1.05	ns, Max
$T_{RCKO_POINTERS}$	Clock CLK to FIFO pointers outputs[7]	0.94	1.02	1.15	ns, Max
$T_{RCKO_PARITY_ECC}$	Clock CLK to ECCPARITY in ECC encode only mode	0.78	0.85	0.94	ns, Max
$T_{RCKO_SDBIT_ECC}$ and $T_{RCKO_SDBIT_ECC_REG}$	Clock CLK to BITERR (without output register)	2.56	2.95	3.55	ns, Max
	Clock CLK to BITERR (with output register)	0.68	0.76	0.89	ns, Max
$T_{RCKO_RDADDR_ECC}$ and $T_{RCKO_RDADDR_ECC_REG}$	Clock CLK to RDADDR output with ECC (without output register)	0.75	0.88	1.07	ns, Max
	Clock CLK to RDADDR output with ECC (with output register)	0.84	0.93	1.08	ns, Max
Setup and Hold Times Before/After Clock CLK					
$T_{RCCK_ADDRA}/T_{RCKC_ADDRA}$	ADDR inputs[8]	0.45/0.31	0.49/0.33	0.57/0.36	ns, Min
$T_{RDCK_DI_WF_NC}/T_{RCKD_DI_WF_NC}$	Data input setup/hold time when block RAM is configured in WRITE_FIRST or NO_CHANGE mode[9]	0.58/0.60	0.65/0.63	0.74/0.67	ns, Min
$T_{RDCK_DI_RF}/T_{RCKD_DI_RF}$	Data input setup/hold time when block RAM is configured in READ_FIRST mode[9]	0.20/0.29	0.22/0.34	0.25/0.41	ns, Min
$T_{RDCK_DI_ECC}/T_{RCKD_DI_ECC}$	DIN inputs with block RAM ECC in standard mode[9]	0.50/0.43	0.55/0.46	0.63/0.50	ns, Min
	DIN inputs with block RAM ECC encode only[9]	0.93/0.43	1.02/0.46	1.17/0.50	ns, Min
	DIN inputs with FIFO ECC in standard mode[9]	1.04/0.56	1.15/0.59	1.32/0.64	ns, Min
$T_{RCCK_INJECTBITERR}/T_{RCKC_INJECTBITERR}$	Inject single/double bit error in ECC mode	0.58/0.35	0.64/0.37	0.74/0.40	ns, Min
$T_{RCCK_RDEN}/T_{RCKC_RDEN}$	Block RAM enable (EN) input	0.35/0.20	0.39/0.21	0.45/0.23	ns, Min
$T_{RCCK_REGCE}/T_{RCKC_REGCE}$	CE input of output register	0.24/0.15	0.29/0.15	0.36/0.16	ns, Min
$T_{RCCK_RSTREG}/T_{RCKC_RSTREG}$	Synchronous RSTREG input	0.29/0.07	0.32/0.07	0.35/0.07	ns, Min
$T_{RCCK_RSTRAM}/T_{RCKC_RSTRAM}$	Synchronous RSTRAM input	0.32/0.42	0.34/0.43	0.36/0.46	ns, Min
$T_{RCCK_WEA}/T_{RCKC_WEA}$	Write Enable (WE) input (block RAM only)	0.44/0.18	0.48/0.19	0.54/0.20	ns, Min
$T_{RCCK_WREN}/T_{RCKC_WREN}$	WREN FIFO inputs	0.46/0.30	0.46/0.35	0.47/0.43	ns, Min
$T_{RCCK_RDEN}/T_{RCKC_RDEN}$	RDEN FIFO inputs	0.42/0.30	0.43/0.35	0.43/0.43	ns, Min

Table 61: **Block RAM and FIFO Switching Characteristics *(Cont'd)***

Symbol	Description	Speed Grade			Units
		-3	-2	-1	
Reset Delays					
T_{RCO_FLAGS}	Reset RST to FIFO flags/pointers[10]	0.90	0.98	1.10	ns, Max
$T_{RREC_RST}/T_{RREM_RST}$	FIFO reset recovery and removal timing[11]	1.87/–0.81	2.07/–0.81	2.37/–0.81	ns, Max
Maximum Frequency					
$F_{MAX_BRAM_WF_NC}$	Block RAM (write first and no change modes) When not in SDP RF mode.	509	460	388	MHz
$F_{MAX_BRAM_RF_PERFORMANCE}$	Block RAM (read first, performance mode) When in SDP RF mode but no address overlap between port A and port B.	509	460	388	MHz
$F_{MAX_BRAM_RF_DELAYED_WRITE}$	Block RAM (read first, delayed_write mode) When in SDP RF mode and there is possibility of overlap between port A and port B addresses.	447	404	339	MHz
$F_{MAX_CAS_WF_NC}$	Block RAM cascade (write first, no change mode) When cascade but not in RF mode.	467	418	345	MHz
$F_{MAX_CAS_RF_PERFORMANCE}$	Block RAM cascade (read first, performance mode) When in cascade with RF mode and no possibility of address overlap/one port is disabled.	467	418	345	MHz
$F_{MAX_CAS_RF_DELAYED_WRITE}$	When in cascade RF mode and there is a possibility of address overlap between port A and port B.	405	362	297	MHz
F_{MAX_FIFO}	FIFO in all modes without ECC	509	460	388	MHz
F_{MAX_ECC}	Block RAM and FIFO in ECC configuration	410	365	297	MHz

Notes:

1. TRACE will report all of these parameters as T_{RCKO_DO}.
2. T_{RCKO_DOR} includes T_{RCKO_DOW}, T_{RCKO_DOPR}, and T_{RCKO_DOPW} as well as the B port equivalent timing parameters.
3. These parameters also apply to synchronous FIFO with DO_REG = 0.
4. T_{RCKO_DO} includes T_{RCKO_DOP} as well as the B port equivalent timing parameters.
5. These parameters also apply to multirate (asynchronous) and synchronous FIFO with DO_REG = 1.
6. T_{RCKO_FLAGS} includes the following parameters: T_{RCKO_AEMPTY}, T_{RCKO_AFULL}, T_{RCKO_EMPTY}, T_{RCKO_FULL}, T_{RCKO_RDERR}, and T_{RCKO_WRERR}.
7. $T_{RCKO_POINTERS}$ includes both $T_{RCKO_RDCOUNT}$ and $T_{RCKO_WRCOUNT}$.
8. The ADDR setup and hold must be met when EN is asserted (even when WE is deasserted). Otherwise, block RAM data corruption is possible.
9. These parameters include both A and B inputs as well as the parity inputs of A and B.
10. T_{RCO_FLAGS} includes the following flags: AEMPTY, AFULL, EMPTY, FULL, RDERR, WRERR, RDCOUNT, and WRCOUNT.
11. RDEN and WREN must be held Low prior to and during reset. The FIFO reset must be asserted for at least five positive clock edges of the slowest clock (WRCLK or RDCLK).

DSP48E1 Switching Characteristics

Table 62: **DSP48E1 Switching Characteristics**

Symbol	Description	Speed Grade			Units
		-3	-2	-1	
Setup and Hold Times of Data/Control Pins to the Input Register Clock					
$T_{DSPDCK_A_AREG}$/ $T_{DSPCKD_A_AREG}$	A input to A register CLK	0.26/0.12	0.30/0.13	0.37/0.14	ns
$T_{DSPDCK_B_BREG}$/$T_{DSPCKD_B_BREG}$	B input to B register CLK	0.33/0.15	0.38/0.16	0.45/0.18	ns
$T_{DSPDCK_C_CREG}$/$T_{DSPCKD_C_CREG}$	C input to C register CLK	0.17/0.17	0.20/0.19	0.24/0.21	ns
$T_{DSPDCK_D_DREG}$/$T_{DSPCKD_D_DREG}$	D input to D register CLK	0.25/0.18	0.32/0.20	0.42/0.22	ns
$T_{DSPDCK_ACIN_AREG}$/$T_{DSPCKD_ACIN_AREG}$	ACIN input to A register CLK	0.23/0.12	0.27/0.13	0.32/0.14	ns
$T_{DSPDCK_BCIN_BREG}$/$T_{DSPCKD_BCIN_BREG}$	BCIN input to B register CLK	0.25/0.15	0.29/0.16	0.36/0.18	ns
Setup and Hold Times of Data Pins to the Pipeline Register Clock					
$T_{DSPDCK_\{A, B\}_MREG_MULT}$/ $T_{DSPCKD_B_MREG_MULT}$	{A, B,} input to M register CLK using multiplier	2.40/–0.01	2.76/–0.01	3.29/–0.01	ns
$T_{DSPDCK_\{A, B\}_ADREG}$/ $T_{DSPCKD_ D_ADREG}$	{A, D} input to AD register CLK	1.29/–0.02	1.48/–0.02	1.76/–0.02	ns
Setup and Hold Times of Data/Control Pins to the Output Register Clock					
$T_{DSPDCK_\{A, B\}_PREG_MULT}$/ $T_{DSPCKD_\{A, B\}\ _PREG_MULT}$	{A, B} input to P register CLK using multiplier	4.02/–0.28	4.60/–0.28	5.48/–0.28	ns
$T_{DSPDCK_D_PREG_MULT}$/ $T_{DSPCKD_D_PREG_MULT}$	D input to P register CLK using multiplier	3.93/–0.73	4.50/–0.73	5.35/–0.73	ns
$T_{DSPDCK_\{A, B\}\ _PREG}$/ $T_{DSPCKD_\{A, B\}\ _PREG}$	A or B input to P register CLK not using multiplier	1.73/–0.28	1.98/–0.28	2.35/–0.28	ns
$T_{DSPDCK_C_PREG}$/ $T_{DSPCKD_C_PREG}$	C input to P register CLK not using multiplier	1.54/–0.26	1.76/–0.26	2.10/–0.26	ns
$T_{DSPDCK_PCIN_PREG}$/ $T_{DSPCKD_PCIN_PREG}$	PCIN input to P register CLK	1.32/–0.15	1.51/–0.15	1.80/–0.15	ns
Setup and Hold Times of the CE Pins					
$T_{DSPDCK_\{CEA;CEB\}_\{AREG;BREG\}}$/ $T_{DSPCKD_\{CEA;CEB\}_\{AREG;BREG\}}$	{CEA; CEB} input to {A; B} register CLK	0.35/0.06	0.42/0.08	0.52/0.11	ns
$T_{DSPDCK_CEC_CREG}$/ $T_{DSPCKD_CEC_CREG}$	CEC input to C register CLK	0.28/0.10	0.34/0.11	0.42/0.13	ns
$T_{DSPDCK_CED_DREG}$/ $T_{DSPCKD_CED_DREG}$	CED input to D register CLK	0.36/–0.03	0.43/–0.03	0.52/–0.03	ns
$T_{DSPDCK_CEM_MREG}$/ $T_{DSPCKD_CEM_MREG}$	CEM input to M register CLK	0.17/0.18	0.21/0.20	0.27/0.23	ns
$T_{DSPDCK_CEP_PREG}$/ $T_{DSPCKD_CEP_PREG}$	CEP input to P register CLK	0.36/0.01	0.43/0.01	0.53/0.01	ns
Setup and Hold Times of the RST Pins					
$T_{DSPDCK_\{RSTA; RSTB\}_\{AREG; BREG\}}$/ $T_{DSPCKD_\{RSTA; RSTB\}_\{AREG; BREG\}}$	{RSTA, RSTB} input to {A, B} register CLK	0.41/0.11	0.46/0.13	0.55/0.15	ns
$T_{DSPDCK_RSTC_CREG}$/ $T_{DSPCKD_RSTC_CREG}$	RSTC input to C register CLK	0.07/0.10	0.08/0.11	0.09/0.12	ns
$T_{DSPDCK_RSTD_DREG}$/ $T_{DSPCKD_RSTD_DREG}$	RSTD input to D register CLK	0.44/0.07	0.50/0.08	0.59/0.09	ns
$T_{DSPDCK_RSTM_MREG}$/ $T_{DSPCKD_RSTM_MREG}$	RSTM input to M register CLK	0.21/0.22	0.23/0.24	0.27/0.28	ns
$T_{DSPDCK_RSTP_PREG}$/ $T_{DSPCKD_RSTP_PREG}$	RSTP input to P register CLK	0.27/0.01	0.30/0.01	0.35/0.01	ns

Table 62: **DSP48E1 Switching Characteristics *(Cont'd)***

Symbol	Description	Speed Grade			Units
		-3	-2	-1	
Combinatorial Delays from Input Pins to Output Pins					
$T_{DSPDO_A_CARRYOUT_MULT}$	A input to CARRYOUT output using multiplier	3.79	4.35	5.18	ns
$T_{DSPDO_D_P_MULT}$	D input to P output using multiplier	3.72	4.26	5.07	ns
$T_{DSPDO_B_P}$	B input to P output not using multiplier	1.53	1.75	2.08	ns
$T_{DSPDO_C_P}$	C input to P output	1.33	1.53	1.82	ns
Combinatorial Delays from Input Pins to Cascading Output Pins					
$T_{DSPDO_\{A;\ B\}_\{ACOUT;\ BCOUT\}}$	{A, B} input to {ACOUT, BCOUT} output	0.55	0.63	0.74	ns
$T_{DSPDO_\{A,\ B\}_CARRYCASCOUT_MULT}$	{A, B} input to CARRYCASCOUT output using multiplier	4.06	4.65	5.54	ns
$T_{DSPDO_D_CARRYCASCOUT_MULT}$	D input to CARRYCASCOUT output using multiplier	3.97	4.54	5.40	ns
$T_{DSPDO_\{A,\ B\}_CARRYCASCOUT}$	{A, B} input to CARRYCASCOUT output not using multiplier	1.77	2.03	2.41	ns
$T_{DSPDO_C_CARRYCASCOUT}$	C input to CARRYCASCOUT output	1.58	1.81	2.15	ns
Combinatorial Delays from Cascading Input Pins to All Output Pins					
$T_{DSPDO_ACIN_P_MULT}$	ACIN input to P output using multiplier	3.65	4.19	5.00	ns
$T_{DSPDO_ACIN_P}$	ACIN input to P output not using multiplier	1.37	1.57	1.88	ns
$T_{DSPDO_ACIN_ACOUT}$	ACIN input to ACOUT output	0.38	0.44	0.53	ns
$T_{DSPDO_ACIN_CARRYCASCOUT_MULT}$	ACIN input to CARRYCASCOUT output using multiplier	3.90	4.47	5.33	ns
$T_{DSPDO_ACIN_CARRYCASCOUT}$	ACIN input to CARRYCASCOUT output not using multiplier	1.61	1.85	2.21	ns
$T_{DSPDO_PCIN_P}$	PCIN input to P output	1.11	1.28	1.52	ns
$T_{DSPDO_PCIN_CARRYCASCOUT}$	PCIN input to CARRYCASCOUT output	1.36	1.56	1.85	ns
Clock to Outs from Output Register Clock to Output Pins					
$T_{DSPCKO_P_PREG}$	CLK PREG to P output	0.33	0.37	0.44	ns
$T_{DSPCKO_CARRYCASCOUT_PREG}$	CLK PREG to CARRYCASCOUT output	0.52	0.59	0.69	ns
Clock to Outs from Pipeline Register Clock to Output Pins					
$T_{DSPCKO_P_MREG}$	CLK MREG to P output	1.68	1.93	2.31	ns
$T_{DSPCKO_CARRYCASCOUT_MREG}$	CLK MREG to CARRYCASCOUT output	1.92	2.21	2.64	ns
$T_{DSPCKO_P_ADREG_MULT}$	CLK ADREG to P output using multiplier	2.72	3.10	3.69	ns
$T_{DSPCKO_CARRYCASCOUT_ADREG_MULT}$	CLK ADREG to CARRYCASCOUT output using multiplier	2.96	3.38	4.02	ns
Clock to Outs from Input Register Clock to Output Pins					
$T_{DSPCKO_P_AREG_MULT}$	CLK AREG to P output using multiplier	3.94	4.51	5.37	ns
$T_{DSPCKO_P_BREG}$	CLK BREG to P output not using multiplier	1.64	1.87	2.22	ns
$T_{DSPCKO_P_CREG}$	CLK CREG to P output not using multiplier	1.69	1.93	2.30	ns
$T_{DSPCKO_P_DREG_MULT}$	CLK DREG to P output using multiplier	3.91	4.48	5.32	ns

Table 62: **DSP48E1 Switching Characteristics *(Cont'd)***

Symbol	Description	Speed Grade			Units
		-3	-2	-1	
Clock to Outs from Input Register Clock to Cascading Output Pins					
$T_{DSPCKO_\{ACOUT;\ BCOUT\}_\{AREG;\ BREG\}}$	CLK (ACOUT, BCOUT) to {A,B} register output	0.64	0.73	0.87	ns
$T_{DSPCKO_CARRYCASCOUT_\{AREG,\ BREG\}_MULT}$	CLK (AREG, BREG) to CARRYCASCOUT output using multiplier	4.19	4.79	5.70	ns
$T_{DSPCKO_CARRYCASCOUT_\ BREG}$	CLK BREG to CARRYCASCOUT output not using multiplier	1.88	2.15	2.55	ns
$T_{DSPCKO_CARRYCASCOUT_\ DREG_MULT}$	CLK DREG to CARRYCASCOUT output using multiplier	4.16	4.76	5.65	ns
$T_{DSPCKO_CARRYCASCOUT_\ CREG}$	CLK CREG to CARRYCASCOUT output	1.94	2.21	2.63	ns
Maximum Frequency					
F_{MAX}	With all registers used	628	550	464	MHz
F_{MAX_PATDET}	With pattern detector	531	465	392	MHz
$F_{MAX_MULT_NOMREG}$	Two register multiply without MREG	349	305	257	MHz
$F_{MAX_MULT_NOMREG_PATDET}$	Two register multiply without MREG with pattern detect	317	277	233	MHz
$F_{MAX_PREADD_MULT_NOADREG}$	Without ADREG	397	346	290	MHz
$F_{MAX_PREADD_MULT_NOADREG_PATDET}$	Without ADREG with pattern detect	397	346	290	MHz
$F_{MAX_NOPIPELINEREG}$	Without pipeline registers (MREG, ADREG)	260	227	190	MHz
$F_{MAX_NOPIPELINEREG_PATDET}$	Without pipeline registers (MREG, ADREG) with pattern detect	241	211	177	MHz

Clock Buffers and Networks

Table 63: **Global Clock Switching Characteristics (Including BUFGCTRL)**

Symbol	Description	Speed Grade			Units
		-3	-2	-1	
$T_{BCCCK_CE}/T_{BCCKC_CE}$[1]	CE pins setup/hold	0.14/0.24	0.14/0.26	0.20/0.32	ns
T_{BCCCK_S}/T_{BCCKC_S}[1]	S pins setup/hold	0.14/0.24	0.14/0.26	0.20/0.32	ns
T_{BCCKO_O}[2]	BUFGCTRL delay from I0/I1 to O	0.09	0.09	0.12	ns
Maximum Frequency					
F_{MAX_BUFG}	Global clock tree (BUFG)	628	550	464	MHz

Notes:

1. T_{BCCCK_CE} and T_{BCCKC_CE} must be satisfied to assure glitch-free operation of the global clock when switching between clocks. These parameters do not apply to the BUFGMUX primitive that assures glitch-free operation. The other global clock setup and hold times are optional; only needing to be satisfied if device operation requires simulation matches on a cycle-for-cycle basis when switching between clocks.
2. T_{BGCKO_O} (BUFG delay from I0 to O) values are the same as T_{BCCKO_O} values.

Table 64: **Input/Output Clock Switching Characteristics (BUFIO)**

Symbol	Description	Speed Grade			Units
		-3	-2	-1	
T_{BIOCKO_O}	Clock to out delay from I to O	0.96	1.06	1.36	ns
Maximum Frequency					
F_{MAX_BUFIO}	I/O clock tree (BUFIO)	680	680	600	MHz

Table 65: **Regional Clock Buffer Switching Characteristics (BUFR)**

Symbol	Description	Speed Grade			Units
		-3	-2	-1	
T_{BRCKO_O}	Clock to out delay from I to O	0.55	0.58	0.76	ns
$T_{BRCKO_O_BYP}$	Clock to out delay from I to O with divide bypass attribute set	0.20	0.23	0.36	ns
T_{BRDO_O}	Propagation delay from CLR to O	0.74	0.81	0.95	ns
Maximum Frequency					
F_{MAX_BUFR}[1]	Regional clock tree (BUFR)	420	375	315	MHz

Notes:

1. The maximum input frequency to the BUFR is the BUFIO F_{MAX} frequency.

Table 66: **Horizontal Clock Buffer Switching Characteristics (BUFH)**

Symbol	Description	Speed Grade			Units
		-3	-2	-1	
T_{BHCKO_O}	BUFH delay from I to O	0.11	0.11	0.15	ns
$T_{BHCCK_CE}/T_{BHCKC_CE}$	CE pin setup and hold	0.21/0.14	0.23/0.15	0.27/0.22	ns
Maximum Frequency					
F_{MAX_BUFH}	Horizontal clock buffer (BUFH)	628	550	464	MHz

Table 67: **Duty-Cycle Distortion and Clock-Tree Skew**

Symbol	Description	Device	Speed Grade			Units
			-3	-2	-1	
T_{DCD_CLK}	Global clock tree duty-cycle distortion[1]	All	0.20	0.20	0.20	ns
T_{CKSKEW}	Global clock tree skew[2]	XC7Z010	0.24	0.24	0.24	ns
		XC7Z020	0.30	0.34	0.37	ns
T_{DCD_BUFIO}	I/O clock tree duty-cycle distortion	All	0.15	0.15	0.15	ns
$T_{BUFIOSKEW}$	I/O clock tree skew across one clock region	All	0.02	0.02	0.03	ns
T_{DCD_BUFR}	Regional clock tree duty-cycle distortion	All	0.18	0.18	0.18	ns

Notes:

1. These parameters represent the worst-case duty-cycle distortion observable at the pins of the device using LVDS output buffers. For cases where other I/O standards are used, IBIS can be used to calculate any additional duty-cycle distortion that might be caused by asymmetrical rise/fall times.
2. The T_{CKSKEW} value represents the worst-case clock-tree skew observable between sequential I/O elements. Significantly less clock-tree skew exists for I/O registers that are close to each other and fed by the same or adjacent clock-tree branches. Use the Xilinx FPGA_Editor and Timing Analyzer tools to evaluate application specific clock skew.

MMCM Switching Characteristics

Table 68: **MMCM Specification**

Symbol	Description	Speed Grade			Units
		-3	-2	-1	
$MMCM_F_{INMAX}$	Maximum input clock frequency	800	800	800	MHz
$MMCM_F_{INMIN}$	Minimum input clock frequency	10	10	10	MHz
$MMCM_F_{INJITTER}$	Maximum input clock period jitter	< 20% of clock input period or 1 ns Max			
$MMCM_F_{INDUTY}$	Allowable input duty cycle: 10—49 MHz	25	25	25	%
	Allowable input duty cycle: 50—199 MHz	30	30	30	%
	Allowable input duty cycle: 200—399 MHz	35	35	35	%
	Allowable input duty cycle: 400—499 MHz	40	40	40	%
	Allowable input duty cycle: >500 MHz	45	45	45	%
$MMCM_F_{MIN_PSCLK}$	Minimum dynamic phase-shift clock frequency	0.01	0.01	0.01	MHz
$MMCM_F_{MAX_PSCLK}$	Maximum dynamic phase-shift clock frequency	550	500	450	MHz
$MMCM_F_{VCOMIN}$	Minimum MMCM VCO frequency	600	600	600	MHz
$MMCM_F_{VCOMAX}$	Maximum MMCM VCO frequency	1600	1440	1200	MHz
$MMCM_F_{BANDWIDTH}$	Low MMCM bandwidth at typical[1]	1.00	1.00	1.00	MHz
	High MMCM bandwidth at typical[1]	4.00	4.00	4.00	MHz
$MMCM_T_{STATPHAOFFSET}$	Static phase offset of the MMCM outputs[2]	0.12	0.12	0.12	ns
$MMCM_T_{OUTJITTER}$	PLL output jitter[3]	Note 1			
$MMCM_T_{OUTDUTY}$	MMCM output clock duty-cycle precision[4]	0.20	0.20	0.20	ns
$MMCM_T_{LOCKMAX}$	MMCM maximum lock time	100	100	100	µs
$MMCM_F_{OUTMAX}$	MMCM maximum output frequency	800	800	800	MHz
$MMCM_F_{OUTMIN}$	MMCM minimum output frequency[5][6]	4.69	4.69	4.69	MHz
$MMCM_T_{EXTFDVAR}$	External clock feedback variation	< 20% of clock input period or 1 ns Max			
$MMCM_RST_{MINPULSE}$	Minimum reset pulse width	5.00	5.00	5.00	ns

Table 68: **MMCM Specification *(Cont'd)***

Symbol	Description	Speed Grade			Units
		-3	-2	-1	
$MMCM_F_{PFDMAX}$	Maximum frequency at the phase frequency detector with bandwidth set to High or optimized	550	500	450	MHz
	Maximum frequency at the phase frequency detector with bandwidth set to Low	300	300	300	MHz
$MMCM_F_{PFDMIN}$	Minimum frequency at the phase frequency detector	10	10	10	MHz
$MMCM_T_{FBDELAY}$	Maximum delay in the feedback path	3 ns Max or one CLKIN cycle			
MMCM Switching Characteristics Setup and Hold					
$T_{MMCMDCK_PSEN}$/ $T_{MMCMCKD_PSEN}$	Setup and hold of phase-shift enable	1.04/0.00	1.04/0.00	1.04/0.00	ns
$T_{MMCMDCK_PSINCDEC}$/ $T_{MMCMCKD_PSINCDEC}$	Setup and hold of phase-shift increment/decrement	1.04/0.00	1.04/0.00	1.04/0.00	ns
$T_{MMCMCKO_PSDONE}$	Phase shift clock to out of PSDONE	0.59	0.68	0.81	ns
Dynamic Reconfiguration Port (DRP) for MMCM Before and After DCLK					
$T_{MMCMDCK_DADDR}$/ $T_{MMCMCKD_DADDR}$	DADDR setup/hold	1.25/0.15	1.40/0.15	1.63/0.15	ns, Min
$T_{MMCMDCK_DI}$/ $T_{MMCMCKD_DI}$	DI setup/hold	1.25/0.15	1.40/0.15	1.63/0.15	ns, Min
$T_{MMCMDCK_DEN}$/ $T_{MMCMCKD_DEN}$	DEN setup/hold	1.76/0.00	1.97/0.00	2.29/0.00	ns, Min
$T_{MMCMDCK_DWE}$/ $T_{MMCMCKD_DWE}$	DWE setup/hold	1.25/0.15	1.40/0.15	1.63/0.15	ns, Min
$T_{MMCMCKO_DRDY}$	CLK to out of DRDY	0.65	0.72	0.99	ns, Max
F_{DCK}	DCLK frequency	200	200	200	MHz, Max

Notes:

1. The MMCM does not filter typical spread-spectrum input clocks because they are usually far below the bandwidth filter frequencies.
2. The static offset is measured between any MMCM outputs with identical phase.
3. Values for this parameter are available in the Clocking Wizard. See http://www.xilinx.com/products/intellectual-property/clocking_wizard.htm.
4. Includes global clock buffer.
5. Calculated as $F_{VCO}/128$ assuming output duty cycle is 50%.
6. When CLKOUT4_CASCADE = TRUE, $MMCM_F_{OUTMIN}$ is 0.036 MHz.

PLL Switching Characteristics

Table 69: **PLL Specification**

Symbol	Description	Speed Grade			Units
		-3	-2	-1	
PLL_F_{INMAX}	Maximum input clock frequency	800	800	800	MHz
PLL_F_{INMIN}	Minimum input clock frequency	19	19	19	MHz
$PLL_F_{INJITTER}$	Maximum input clock period jitter	< 20% of clock input period or 1 ns Max			
PLL_F_{INDUTY}	Allowable input duty cycle: 19—49 MHz	25	25	25	%
	Allowable input duty cycle: 50—199 MHz	30	30	30	%
	Allowable input duty cycle: 200—399 MHz	35	35	35	%
	Allowable input duty cycle: 400—499 MHz	40	40	40	%
	Allowable input duty cycle: >500 MHz	45	45	45	%
PLL_F_{VCOMIN}	Minimum PLL VCO frequency	800	800	800	MHz
PLL_F_{VCOMAX}	Maximum PLL VCO frequency	2133	1866	1600	MHz
$PLL_F_{BANDWIDTH}$	Low PLL bandwidth at typical(1)	1.00	1.00	1.00	MHz
	High PLL bandwidth at typical(1)	4.00	4.00	4.00	MHz
$PLL_T_{STATPHAOFFSET}$	Static phase offset of the PLL outputs(2)	0.12	0.12	0.12	ns
$PLL_T_{OUTJITTER}$	PLL output jitter(3)	Note 1			
$PLL_T_{OUTDUTY}$	PLL output clock duty-cycle precision(4)	0.20	0.20	0.20	ns
$PLL_T_{LOCKMAX}$	PLL maximum lock time	100	100	100	µs
PLL_F_{OUTMAX}	PLL maximum output frequency	800	800	800	MHz
PLL_F_{OUTMIN}	PLL minimum output frequency(5)	6.25	6.25	6.25	MHz
$PLL_T_{EXTFDVAR}$	External clock feedback variation	< 20% of clock input period or 1 ns Max			
$PLL_RST_{MINPULSE}$	Minimum reset pulse width	5.00	5.00	5.00	ns
PLL_F_{PFDMAX}	Maximum frequency at the phase frequency detector with bandwidth set to High or optimized	550	500	450	MHz
	Maximum frequency at the phase frequency detector with bandwidth set to Low	300	300	300	MHz
PLL_F_{PFDMIN}	Minimum frequency at the phase frequency detector	19	19	19	MHz
$PLL_T_{FBDELAY}$	Maximum delay in the feedback path	3 ns Max or one CLKIN cycle			
Dynamic Reconfiguration Port (DRP) for PLL Before and After DCLK					
$T_{PLLCCK_DADDR}/T_{PLLCKC_DADDR}$	DADDR setup/hold	1.25/0.15	1.40/0.15	1.63/0.15	ns, Min
$T_{PLLCCK_DI}/T_{PLLCKC_DI}$	DI setup/hold	1.25/0.15	1.40/0.15	1.63/0.15	ns, Min
$T_{PLLCCK_DEN}/T_{PLLCKC_DEN}$	DEN setup/hold	1.76/0.00	1.97/0.00	2.29/0.00	ns, Min
$T_{PLLCCK_DWE}/T_{PLLCKC_DWE}$	DWE setup/hold	1.25/0.15	1.40/0.15	1.63/0.15	ns, Min
T_{PLLCKO_DRDY}	CLK to out of DRDY	0.65	0.72	0.99	ns, Max
F_{DCK}	DCLK frequency	200	200	200	MHz, Max

Notes:

1. The PLL does not filter typical spread-spectrum input clocks because they are usually far below the bandwidth filter frequencies.
2. The static offset is measured between any PLL outputs with identical phase.
3. Values for this parameter are available in the Clocking Wizard. See http://www.xilinx.com/products/intellectual-property/clocking_wizard.htm.
4. Includes global clock buffer.
5. Calculated as $F_{VCO}/128$ assuming output duty cycle is 50%.

Device Pin-to-Pin Output Parameter Guidelines

Table 70: **Clock-Capable Clock Input to Output Delay Without MMCM/PLL (Near Clock Region)**

Symbol	Description	Device	Speed Grade			Units
			-3	-2	-1	
SSTL15 Clock-Capable Clock Input to Output Delay using Output Flip-Flops, Fast Slew Rate, *without* MMCM/PLL.						
T_{ICKOF}	Clock-capable clock input and OUTFF without MMCM/PLL (near clock region)	XC7Z010	6.06	6.49	7.73	ns
		XC7Z020	6.41	6.86	8.13	ns

Notes:

1. This table lists representative values where one global clock input drives one vertical clock line in each accessible column, and where all accessible IOB and CLB flip-flops are clocked by the global clock net.

Table 71: **Clock-Capable Clock Input to Output Delay Without MMCM/PLL (Far Clock Region)**

Symbol	Description	Device	Speed Grade			Units
			-3	-2	-1	
SSTL15 Clock-Capable Clock Input to Output Delay using Output Flip-Flops, Fast Slew Rate, *without* MMCM/PLL.						
$T_{ICKOFFAR}$	Clock-capable clock input and OUTFF *without* MMCM/PLL (far clock region)	XC7Z010	6.06	6.49	7.73	ns
		XC7Z020	6.72	7.15	8.51	ns

Notes:

1. This table lists representative values where one global clock input drives one vertical clock line in each accessible column, and where all accessible IOB and CLB flip-flops are clocked by the global clock net.

Table 72: **Clock-Capable Clock Input to Output Delay With MMCM**

Symbol	Description	Device	Speed Grade			Units
			-3	-2	-1	
SSTL15 Clock-Capable Clock Input to Output Delay using Output Flip-Flops, Fast Slew Rate, *with* MMCM.						
$T_{ICKOFMMCMCC}$	Clock-capable clock input and OUTFF *with* MMCM	XC7Z010	2.68	1.56	1.73	ns
		XC7Z020	2.71	1.60	1.76	ns

Notes:

1. This table lists representative values where one global clock input drives one vertical clock line in each accessible column, and where all accessible IOB and CLB flip-flops are clocked by the global clock net.
2. MMCM output jitter is already included in the timing calculation.

Table 73: **Clock-Capable Clock Input to Output Delay With PLL**

Symbol	Description	Device	Speed Grade			Units
			-3	-2	-1	
SSTL15 Clock-Capable Clock Input to Output Delay using Output Flip-Flops, Fast Slew Rate, *with* PLL.						
$T_{ICKOFPLLCC}$	Clock-capable clock input and OUTFF *with* PLL	XC7Z010	1.31	1.23	1.40	ns
		XC7Z020	1.34	1.27	1.43	ns

Notes:

1. This table lists representative values where one global clock input drives one vertical clock line in each accessible column, and where all accessible IOB and CLB flip-flops are clocked by the global clock net.
2. PLL output jitter is already included in the timing calculation.

Table 74: **Pin-to-Pin, Clock-to-Out using BUFIO**

Symbol	Description	Speed Grade			Units
		-3	-2	-1	
$T_{ICKOFCS}$	Clock to out of I/O clock	6.19	6.74	8.03	ns

Device Pin-to-Pin Input Parameter Guidelines

Table 75: **Global Clock Input Setup and Hold Without MMCM/PLL with ZHOLD_DELAY on HR I/O Banks**

Symbol	Description	Device	Speed Grade			Units
			-3	-2	-1	
Input Setup and Hold Time Relative to Global Clock Input Signal for SSTL15 Standard.[1]						
T_{PSFD}/ T_{PHFD}	Full delay (legacy delay or default delay) Global clock output and IFF[2] without MMCM/PLL with ZHOLD_DELAY on HR I/O banks	XC7Z010	1.73/–0.37	2.49/–0.37	2.97/–0.37	ns
		XC7Z020	2.23/–0.38	2.77/–0.38	2.98/–0.38	ns

Notes:

1. Setup and hold times are measured over worst case conditions (process, voltage, temperature). Setup time is measured relative to the global clock input signal using the slowest process, highest temperature, and lowest voltage. Hold time is measured relative to the global clock input signal using the fastest process, lowest temperature, and highest voltage.
2. IFF = Input flip-flop or latch
3. A Zero "0" hold time listing indicates no hold time or a negative hold time.

Table 76: **Clock-Capable Clock Input Setup and Hold With MMCM**

Symbol	Description	Device	Speed Grade			Units
			-3	-2	-1	
Input Setup and Hold Time Relative to Global Clock Input Signal for SSTL15 Standard.[1]						
$T_{PSMMCMCC}$/ $T_{PHMMCMCC}$	No delay clock-capable clock input and IFF[2] with MMCM	XC7Z010	1.60/–0.37	2.17/–0.37	2.35/–0.37	ns
		XC7Z020	1.73/–0.31	2.64/–0.31	3.15/–0.31	ns

Notes:

1. Setup and hold times are measured over worst case conditions (process, voltage, temperature). Setup time is measured relative to the global clock input signal using the slowest process, highest temperature, and lowest voltage. Hold time is measured relative to the global clock input signal using the fastest process, lowest temperature, and highest voltage.
2. IFF = Input flip-flop or latch
3. Use IBIS to determine any duty-cycle distortion incurred using various standards.

Table 77: **Clock-Capable Clock Input Setup and Hold With PLL**

Symbol	Description	Device	Speed Grade			Units
			-3	-2	-1	
Input Setup and Hold Time Relative to Clock-Capable Clock Input Signal for SSTL15 Standard.[1]						
$T_{PSPLLCC}$/ $T_{PHPLLCC}$	No delay clock-capable clock input and IFF[2] with PLL	XC7Z010	2.30/–0.50	2.80/–0.50	3.32/–0.50	ns
		XC7Z020	2.44/–0.44	2.95/–0.44	3.49/–0.44	ns

Notes:

1. Setup and hold times are measured over worst case conditions (process, voltage, temperature). Setup time is measured relative to the global clock input signal using the slowest process, highest temperature, and lowest voltage. Hold time is measured relative to the global clock input signal using the fastest process, lowest temperature, and highest voltage.
2. IFF = Input flip-flop or latch
3. Use IBIS to determine any duty-cycle distortion incurred using various standards.

Table 78: **Data Input Setup and Hold Times Relative to a Forwarded Clock Input Pin Using BUFIO**

Symbol	Description	Speed Grade			Units
		-3	-2	-1	
T_{PSCS}/T_{PHCS}	Setup and hold of I/O clock	–0.41/1.33	–0.41/1.45	–0.41/1.70	ns

Table 79: **Sample Window**

Symbol	Description	Speed Grade			Units
		-3	-2	-1	
T_{SAMP}	Sampling error at receiver pins(1)	0.61	0.67	0.72	ns
T_{SAMP_BUFIO}	Sampling error at receiver pins using BUFIO(2)	0.36	0.42	0.48	ns

Notes:

1. This parameter indicates the total sampling error of the PL DDR input registers, measured across voltage, temperature, and process. The characterization methodology uses the MMCM to capture the DDR input registers' edges of operation. These measurements include:
   - CLK0 MMCM jitter
   - MMCM accuracy (phase offset)
   - MMCM phase shift resolution
   These measurements do not include package or clock tree skew.
2. This parameter indicates the total sampling error of the PL DDR input registers, measured across voltage, temperature, and process. The characterization methodology uses the BUFIO clock network and IDELAY to capture the DDR input registers' edges of operation. These measurements do not include package or clock tree skew.

Additional Package Parameter Guidelines

The parameters in this section provide the necessary values for calculating timing budgets for PL clock transmitter and receiver data-valid windows.

Table 80: **Package Skew**

Symbol	Description	Device	Package	Value	Units
$T_{PKGSKEW}$	Package skew(1)	XC7Z010	CLG400		ps
		XC7Z020	CLG400		ps
			CLG484	252	ps

Notes:

1. These values represent the worst-case skew between any two SelectIO resources in the package: shortest flight time to longest flight time from pad to ball (7.0 ps per mm).
2. Package trace length information is available for these device/package combinations. This information can be used to deskew the package.

XADC Specifications

Table 81: **XADC Specifications**

Parameter	Symbol	Comments/Conditions	Min	Typ	Max	Units
V_{CCADC} = 1.8V ± 5%, V_{REFP} = 1.25V, V_{REFN} = 0V, ADCCLK = 26 MHz, T_j = –40°C to 100°C, Typical values at T_j=+40°C						
ADC Accuracy[1]						
Resolution			12	–	–	Bits
Integral Nonlinearity[2]	INL		–	–	±2	LSBs
Differential Nonlinearity	DNL	No missing codes, guaranteed monotonic	–	–	±1	LSBs
Offset Error		Offset calibration enabled	–	–	±4	LSBs
Gain Error		Gain calibration disabled	–	–	±0.4	%
Offset Matching		Offset calibration enabled	–	–	4	LSBs
Gain Matching		Gain calibration disabled	–	–	0.2	%
Sample Rate			0.1	–	1	MS/s
Signal to Noise Ratio[2]	SNR	F_{SAMPLE} = 500KS/s, F_{IN} = 20KHz	60	–	–	dB
RMS Code Noise		External 1.25V reference	–	–	2	LSBs
		On-chip reference	–	3	–	LSBs
Total Harmonic Distortion[2]	THD	F_{SAMPLE} = 500KS/s, F_{IN} = 20KHz	70	–	–	dB
ADC Accuracy at Extended Temperatures (-55°C to 125°C)						
Resolution			10	–	–	Bits
Integral Nonlinearity[2]	INL		–	–	±1	LSB (at 10 bits)
Differential Nonlinearity	DNL	No missing codes, guaranteed monotonic	–	–	±1	
Analog Inputs[3]						
ADC Input Ranges		Unipolar operation	0	–	1	V
		Bipolar operation	–0.5	–	+0.5	V
		Unipolar common mode range (FS input)	0	–	+0.5	V
		Bipolar common mode range (FS input)	+0.5	–	+0.6	V
Maximum External Channel Input Ranges		Adjacent channels set within these ranges should not corrupt measurements on adjacent channels	–0.1	–	V_{CCADC}	V
Auxiliary Channel Full Resolution Bandwidth	FRBW		250	–	–	KHz
On-Chip Sensors						
Temperature Sensor Error		T_j = –40°C to 100°C.	–	–	±4	°C
		T_j = –55°C to +125°C	–	–	±6	°C
Supply Sensor Error		Measurement range of V_{CCAUX} 1.8V ±5% T_j = –40°C to +100°C	–	–	±1	%
		Measurement range of V_{CCAUX} 1.8V ±5% T_j = –55°C to +125°C	–	–	±2	%
Conversion Rate[4]						
Conversion Time - Continuous	t_{CONV}	Number of ADCCLK cycles	26	–	32	
Conversion Time - Event	t_{CONV}	Number of CLK cycles	–	–	21	
DRP Clock Frequency	DCLK	DRP clock frequency	8	–	250	MHz
ADC Clock Frequency	ADCCLK	Derived from DCLK	1	–	26	MHz
DCLK Duty Cycle			40	–	60	%

Table 81: **XADC Specifications *(Cont'd)***

Parameter	Symbol	Comments/Conditions	Min	Typ	Max	Units
XADC Reference[5]						
External Reference	V_{REFP}	Externally supplied reference voltage	1.20	1.25	1.30	V
On-Chip Reference		Ground V_{REFP} pin to AGND, T_j = –40°C to 100°C	1.2375	1.25	1.2625	V

Notes:

1. Offset and gain errors are removed by enabling the XADC automatic gain calibration feature. The values are specified for when this feature is enabled.
2. Only specified for new BitGen option XADCEnhancedLinearity = ON.
3. See the ADC chapter in UG480: *7 Series FPGAs XADC User Guide* for a detailed description.
4. See the Timing chapter in UG480: *7 Series FPGAs XADC User Guide* for a detailed description.
5. Any variation in the reference voltage from the nominal V_{REFP} = 1.25V and V_{REFN} = 0V will result in a deviation from the ideal transfer function. This also impacts the accuracy of the internal sensor measurements (i.e., temperature and power supply). However, for external ratiometric type applications allowing reference to vary by ±4% is permitted. On-chip reference variation is ±1%.

Configuration Switching Characteristics

Table 82: **Configuration Switching Characteristics**

Symbol	Description	Speed Grade			Units
		-3	-2	-1	
Power-up Timing Characteristics					
T_{POR}	Power-on reset	50	50	50	ms, Max
Boundary-Scan Port Timing Specifications					
T_{TAPTCK}/T_{TCKTAP}	TMS and TDI setup/hold	3.0/2.0	3.0/2.0	3.0/2.0	ns, Min
T_{TCKTDO}	TCK falling edge to TDO output	7.0	7.0	7.0	ns, Max
F_{TCK}	TCK frequency	66	66	66	MHz, Max

eFUSE Programming Conditions

Table 83 lists the programming conditions specifically for eFUSE. For more information, see UG470: *7 Series FPGA Configuration User Guide*.

Table 83: **eFUSE Programming Conditions**[1]

Symbol	Description	Min	Typ	Max	Units
I_{FS}	V_{CCAUX} supply current	–	–	115	mA
t_j	Temperature range	15	–	125	°C

Notes:

1. The PL must not be configured during eFUSE programming.

Revision History

The following table shows the revision history for this document:

Date	Version	Description of Revisions
05/07/12	1.0	Initial Xilinx release.
06/27/12	1.1	Updated the descriptions, changed V_{IN}, Note 3, Note 4, and added V_{PREF}, V_{PIN}, and Note 5 in Table 1. In Table 2, updated descriptions and notes. Updated Table 3 and added R_{IN_TERM}. Removed I_{CCMIOQ} from Table 4. Removed I_{CCMIOQ} and updated XC7Z020 in Table 5. Updated LVCMOS12, SSTL135, and SSTL15 in Table 8. Updated Table 15. In PS Performance Characteristics section, added timing diagrams and revised many tables. Updated Table 48 and removed notes 2 and 3. Added Note 2 and Note 3 to Table 49. Changed Table 51 by adding $T_{IOIBUFDISABLE}$. Removed many of the combinatorial delay specifications and T_{CINCK}/T_{CKCIN} from Table 58. In Table 81 updated Offset Error and Matching descriptions and Gain Error and Matching descriptions, and added Note 2 to Integral Nonlinearity.

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