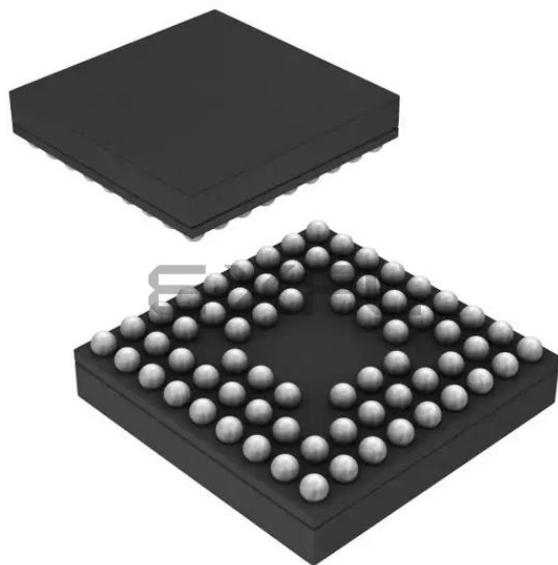




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Understanding [Embedded - CPLDs \(Complex Programmable Logic Devices\)](#)

Embedded - CPLDs, or Complex Programmable Logic Devices, are highly versatile digital logic devices used in electronic systems. These programmable components are designed to perform complex logical operations and can be customized for specific applications. Unlike fixed-function ICs, CPLDs offer the flexibility to reprogram their configuration, making them an ideal choice for various embedded systems. They consist of a set of logic gates and programmable interconnects, allowing designers to implement complex logic circuits without needing custom hardware.

Applications of Embedded - CPLDs

Details

Product Status	Active
Programmable Type	In System Programmable
Delay Time tpd(1) Max	7.5 ns
Voltage Supply - Internal	1.71V ~ 1.89V
Number of Logic Elements/Blocks	160
Number of Macrocells	128
Number of Gates	-
Number of I/O	52
Operating Temperature	0°C ~ 85°C (TJ)
Mounting Type	Surface Mount
Package / Case	68-TFBGA
Supplier Device Package	68-MBGA (5x5)
Purchase URL	https://www.e-xfl.com/product-detail/intel/5m160zm68c5n

Programming/Erase Specifications

Table 3–3 lists the programming/erase specifications for the MAX V device family.

Table 3–3. Programming/Erase Specifications for MAX V Devices

Parameter	Block	Minimum	Typical	Maximum	Unit
Erase and reprogram cycles	UFM	—	—	1000 (1)	Cycles
	Configuration flash memory (CFM)	—	—	100	Cycles

Note to Table 3–3:

(1) This value applies to the commercial grade devices. For the industrial grade devices, the value is 100 cycles.

DC Electrical Characteristics

Table 3–4 lists DC electrical characteristics for the MAX V device family.

Table 3–4. DC Electrical Characteristics for MAX V Devices (Note 1) (Part 1 of 2)

Symbol	Parameter	Conditions	Minimum	Typical	Maximum	Unit
I_I	Input pin leakage current	$V_I = V_{CCIO}$ max to 0 V (2)	–10	—	10	μA
I_{OZ}	Tri-stated I/O pin leakage current	$V_O = V_{CCIO}$ max to 0 V (2)	–10	—	10	μA
$I_{CCSTANDBY}$	V_{CCINT} supply current (standby) (3)	5M40Z, 5M80Z, 5M160Z, and 5M240Z (Commercial grade) (4), (5)	—	25	90	μA
		5M240Z (Commercial grade) (6)	—	27	96	μA
		5M40Z, 5M80Z, 5M160Z, and 5M240Z (Industrial grade) (5), (7)	—	25	139	μA
		5M240Z (Industrial grade) (6)	—	27	152	μA
		5M570Z (Commercial grade) (4)	—	27	96	μA
		5M570Z (Industrial grade) (7)	—	27	152	μA
		5M1270Z and 5M2210Z	—	2	—	mA
$V_{SCHMITT}$ (8)	Hysteresis for Schmitt trigger input (9)	$V_{CCIO} = 3.3$ V	—	400	—	mV
		$V_{CCIO} = 2.5$ V	—	190	—	mV
$I_{CCPOWERUP}$	V_{CCINT} supply current during power-up (10)	MAX V devices	—	—	40	mA
R_{PULLUP}	Value of I/O pin pull-up resistor during user mode and ISP	$V_{CCIO} = 3.3$ V (11)	5	—	25	$k\Omega$
		$V_{CCIO} = 2.5$ V (11)	10	—	40	$k\Omega$
		$V_{CCIO} = 1.8$ V (11)	25	—	60	$k\Omega$
		$V_{CCIO} = 1.5$ V (11)	45	—	95	$k\Omega$
		$V_{CCIO} = 1.2$ V (11)	80	—	130	$k\Omega$

Table 3-4. DC Electrical Characteristics for MAX V Devices (Note 1) (Part 2 of 2)

Symbol	Parameter	Conditions	Minimum	Typical	Maximum	Unit
I_{PULLUP}	I/O pin pull-up resistor current when I/O is unprogrammed	—	—	—	300	μA
C_{IO}	Input capacitance for user I/O pin	—	—	—	8	pF
C_{GCLK}	Input capacitance for dual-purpose GCLK/user I/O pin	—	—	—	8	pF

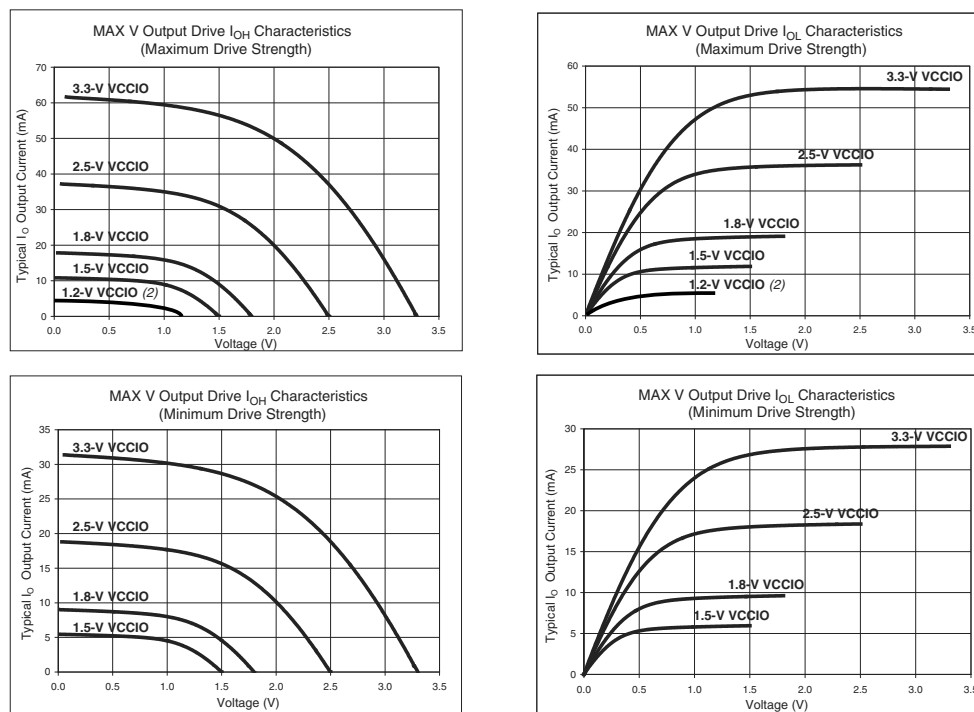
Notes to Table 3-4:

- (1) Typical values are for $T_A = 25^\circ C$, $V_{CCINT} = 1.8 V$ and $V_{CCIO} = 1.2, 1.5, 1.8, 2.5$, or $3.3 V$.
- (2) This value is specified for normal device operation. The value may vary during power-up. This applies to all V_{CCIO} settings (3.3, 2.5, 1.8, 1.5, and 1.2 V).
- (3) $V_I =$ ground, no load, and no toggling inputs.
- (4) Commercial temperature ranges from $0^\circ C$ to $85^\circ C$ with the maximum current at $85^\circ C$.
- (5) Not applicable to the T144 package of the 5M240Z device.
- (6) Only applicable to the T144 package of the 5M240Z device.
- (7) Industrial temperature ranges from $-40^\circ C$ to $100^\circ C$ with the maximum current at $100^\circ C$.
- (8) This value applies to commercial and industrial range devices. For extended temperature range devices, the $V_{SCHMITT}$ typical value is 300 mV for $V_{CCIO} = 3.3 V$ and 120 mV for $V_{CCIO} = 2.5 V$.
- (9) The TCK input is susceptible to high pulse glitches when the input signal fall time is greater than 200 ns for all I/O standards.
- (10) This is a peak current value with a maximum duration of t_{CONFIG} time.
- (11) Pin pull-up resistance values will lower if an external source drives the pin higher than V_{CCIO} .

Output Drive Characteristics

Figure 3–1 shows the typical drive strength characteristics of MAX V devices.

Figure 3–1. Output Drive Characteristics of MAX V Devices (Note 1)



Notes to Figure 3–1:

- (1) The DC output current per pin is subject to the absolute maximum rating of Table 3–1 on page 3–1.
- (2) 1.2-V V_{CCIO} is only applicable to the maximum drive strength.

I/O Standard Specifications

Table 3–5 through Table 3–13 on page 3–8 list the I/O standard specifications for the MAX V device family.

Table 3–5. 3.3-V LVTTTL Specifications for MAX V Devices

Symbol	Parameter	Conditions	Minimum	Maximum	Unit
V_{CCIO}	I/O supply voltage	—	3.0	3.6	V
V_{IH}	High-level input voltage	—	1.7	4.0	V
V_{IL}	Low-level input voltage	—	–0.5	0.8	V
V_{OH}	High-level output voltage	$I_{OH} = -4 \text{ mA}$ (1)	2.4	—	V
V_{OL}	Low-level output voltage	$I_{OL} = 4 \text{ mA}$ (1)	—	0.45	V

Note to Table 3–5:

- (1) This specification is supported across all the programmable drive strength settings available for this I/O standard, as shown in the *MAX V Device Architecture* chapter.

Table 3-6. 3.3-V LVC MOS Specifications for MAX V Devices

Symbol	Parameter	Conditions	Minimum	Maximum	Unit
V_{CCIO}	I/O supply voltage	—	3.0	3.6	V
V_{IH}	High-level input voltage	—	1.7	4.0	V
V_{IL}	Low-level input voltage	—	-0.5	0.8	V
V_{OH}	High-level output voltage	$V_{CCIO} = 3.0$, $IOH = -0.1 \text{ mA}$ (1)	$V_{CCIO} - 0.2$	—	V
V_{OL}	Low-level output voltage	$V_{CCIO} = 3.0$, $IOL = 0.1 \text{ mA}$ (1)	—	0.2	V

Note to Table 3-6:

- (1) This specification is supported across all the programmable drive strength settings available for this I/O standard, as shown in the *MAX V Device Architecture* chapter.

Table 3-7. 2.5-V I/O Specifications for MAX V Devices

Symbol	Parameter	Conditions	Minimum	Maximum	Unit
V_{CCIO}	I/O supply voltage	—	2.375	2.625	V
V_{IH}	High-level input voltage	—	1.7	4.0	V
V_{IL}	Low-level input voltage	—	-0.5	0.7	V
V_{OH}	High-level output voltage	$IOH = -0.1 \text{ mA}$ (1)	2.1	—	V
		$IOH = -1 \text{ mA}$ (1)	2.0	—	V
		$IOH = -2 \text{ mA}$ (1)	1.7	—	V
V_{OL}	Low-level output voltage	$IOL = 0.1 \text{ mA}$ (1)	—	0.2	V
		$IOL = 1 \text{ mA}$ (1)	—	0.4	V
		$IOL = 2 \text{ mA}$ (1)	—	0.7	V

Note to Table 3-7:

- (1) This specification is supported across all the programmable drive strength settings available for this I/O standard, as shown in the *MAX V Device Architecture* chapter.

Table 3-8. 1.8-V I/O Specifications for MAX V Devices

Symbol	Parameter	Conditions	Minimum	Maximum	Unit
V_{CCIO}	I/O supply voltage	—	1.71	1.89	V
V_{IH}	High-level input voltage	—	$0.65 \times V_{CCIO}$	2.25 (2)	V
V_{IL}	Low-level input voltage	—	-0.3	$0.35 \times V_{CCIO}$	V
V_{OH}	High-level output voltage	$IOH = -2 \text{ mA}$ (1)	$V_{CCIO} - 0.45$	—	V
V_{OL}	Low-level output voltage	$IOL = 2 \text{ mA}$ (1)	—	0.45	V

Notes to Table 3-8:

- (1) This specification is supported across all the programmable drive strength settings available for this I/O standard, as shown in the *MAX V Device Architecture* chapter.
- (2) This maximum V_{IH} reflects the JEDEC specification. The MAX V input buffer can tolerate a V_{IH} maximum of 4.0, as specified by the V_I parameter in Table 3-2 on page 3-2.

Table 3–9. 1.5-V I/O Specifications for MAX V Devices

Symbol	Parameter	Conditions	Minimum	Maximum	Unit
V_{CCIO}	I/O supply voltage	—	1.425	1.575	V
V_{IH}	High-level input voltage	—	$0.65 \times V_{CCIO}$	$V_{CCIO} + 0.3$ (2)	V
V_{IL}	Low-level input voltage	—	–0.3	$0.35 \times V_{CCIO}$	V
V_{OH}	High-level output voltage	$IOH = -2 \text{ mA}$ (1)	$0.75 \times V_{CCIO}$	—	V
V_{OL}	Low-level output voltage	$IOL = 2 \text{ mA}$ (1)	—	$0.25 \times V_{CCIO}$	V

Notes to Table 3–9:

- (1) This specification is supported across all the programmable drive strength settings available for this I/O standard, as shown in the *MAX V Device Architecture* chapter.
- (2) This maximum V_{IH} reflects the JEDEC specification. The MAX V input buffer can tolerate a V_{IH} maximum of 4.0, as specified by the V_I parameter in Table 3–2 on page 3–2.

Table 3–10. 1.2-V I/O Specifications for MAX V Devices

Symbol	Parameter	Conditions	Minimum	Maximum	Unit
V_{CCIO}	I/O supply voltage	—	1.14	1.26	V
V_{IH}	High-level input voltage	—	$0.8 \times V_{CCIO}$	$V_{CCIO} + 0.3$	V
V_{IL}	Low-level input voltage	—	–0.3	$0.25 \times V_{CCIO}$	V
V_{OH}	High-level output voltage	$IOH = -2 \text{ mA}$ (1)	$0.75 \times V_{CCIO}$	—	V
V_{OL}	Low-level output voltage	$IOL = 2 \text{ mA}$ (1)	—	$0.25 \times V_{CCIO}$	V

Note to Table 3–10:

- (1) This specification is supported across all the programmable drive strength settings available for this I/O standard, as shown in the *MAX V Device Architecture* chapter.

Table 3–11. 3.3-V PCI Specifications for MAX V Devices (Note 1)

Symbol	Parameter	Conditions	Minimum	Typical	Maximum	Unit
V_{CCIO}	I/O supply voltage	—	3.0	3.3	3.6	V
V_{IH}	High-level input voltage	—	$0.5 \times V_{CCIO}$	—	$V_{CCIO} + 0.5$	V
V_{IL}	Low-level input voltage	—	–0.5	—	$0.3 \times V_{CCIO}$	V
V_{OH}	High-level output voltage	$IOH = -500 \text{ }\mu\text{A}$	$0.9 \times V_{CCIO}$	—	—	V
V_{OL}	Low-level output voltage	$IOL = 1.5 \text{ mA}$	—	—	$0.1 \times V_{CCIO}$	V

Note to Table 3–11:

- (1) 3.3-V PCI I/O standard is only supported in Bank 3 of the 5M1270Z and 5M2210Z devices.

Table 3–12. LVDS Specifications for MAX V Devices (Note 1)

Symbol	Parameter	Conditions	Minimum	Typical	Maximum	Unit
V_{CCIO}	I/O supply voltage	—	2.375	2.5	2.625	V
V_{OD}	Differential output voltage swing	—	247	—	600	mV
V_{OS}	Output offset voltage	—	1.125	1.25	1.375	V

Note to Table 3–12:

- (1) Supports emulated LVDS output using a three-resistor network (LVDS_E_3R).

Table 3–13. RSDS Specifications for MAX V Devices (Note 1)

Symbol	Parameter	Conditions	Minimum	Typical	Maximum	Unit
V_{CCIO}	I/O supply voltage	—	2.375	2.5	2.625	V
V_{OD}	Differential output voltage swing	—	247	—	600	mV
V_{OS}	Output offset voltage	—	1.125	1.25	1.375	V

Note to Table 3–13:

(1) Supports emulated RSDS output using a three-resistor network (RSDS_E_3R).

Bus Hold Specifications

Table 3–14 lists the bus hold specifications for the MAX V device family.

Table 3–14. Bus Hold Specifications for MAX V Devices

Parameter	Conditions	V _{CCIO} Level										Unit
		1.2 V		1.5 V		1.8 V		2.5 V		3.3 V		
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	
Low sustaining current	V _{IN} > V _{IL} (maximum)	10	—	20	—	30	—	50	—	70	—	μA
High sustaining current	V _{IN} < V _{IH} (minimum)	–10	—	–20	—	–30	—	–50	—	–70	—	μA
Low overdrive current	0 V < V _{IN} < V _{CCIO}	—	130	—	160	—	200	—	300	—	500	μA
High overdrive current	0 V < V _{IN} < V _{CCIO}	—	–130	—	–160	—	–200	—	–300	—	–500	μA

Power-Up Timing

Table 3–15 lists the power-up timing characteristics for the MAX V device family.

Table 3–15. Power-Up Timing for MAX V Devices

Symbol	Parameter	Device	Temperature Range	Min	Typ	Max	Unit
t_{CONFIG}	The amount of time from when minimum V_{CCINT} is reached until the device enters user mode (1)	5M40Z	Commercial and industrial	—	—	200	μs
			Extended	—	—	300	μs
		5M80Z	Commercial and industrial	—	—	200	μs
			Extended	—	—	300	μs
		5M160Z	Commercial and industrial	—	—	200	μs
			Extended	—	—	300	μs
		5M240Z (2)	Commercial and industrial	—	—	200	μs
			Extended	—	—	300	μs
		5M240Z (3)	Commercial and industrial	—	—	300	μs
			Extended	—	—	400	μs
		5M570Z	Commercial and industrial	—	—	300	μs
			Extended	—	—	400	μs
		5M1270Z (4)	Commercial and industrial	—	—	300	μs
			Extended	—	—	400	μs
		5M1270Z (5)	Commercial and industrial	—	—	450	μs
			Extended	—	—	500	μs
		5M2210Z	Commercial and industrial	—	—	450	μs
			Extended	—	—	500	μs

Notes to Table 3–15:

- (1) For more information about power-on reset (POR) trigger voltage, refer to the *Hot Socketing and Power-On Reset in MAX V Devices* chapter.
- (2) Not applicable to the T144 package of the 5M240Z device.
- (3) Only applicable to the T144 package of the 5M240Z device.
- (4) Not applicable to the F324 package of the 5M1270Z device.
- (5) Only applicable to the F324 package of the 5M1270Z device.

Power Consumption

You can use the Altera® PowerPlay Early Power Estimator and PowerPlay Power Analyzer to estimate the device power.

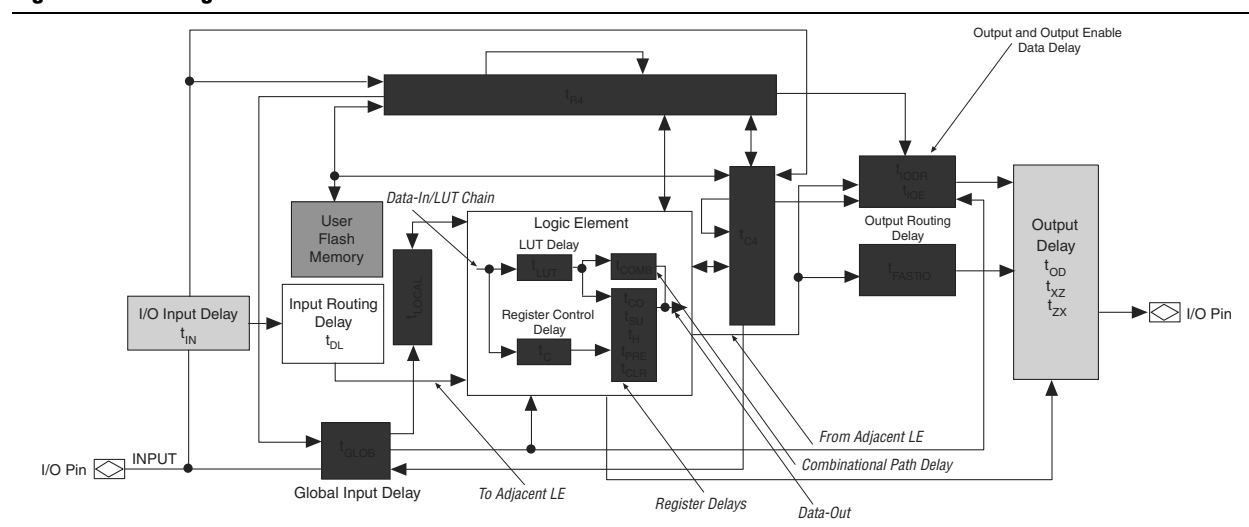
For more information about these power analysis tools, refer to the *PowerPlay Early Power Estimator for Altera CPLDs User Guide* and the *PowerPlay Power Analysis* chapter in volume 3 of the *Quartus II Handbook*.

Timing Model and Specifications

MAX V devices timing can be analyzed with the Altera Quartus® II software, a variety of industry-standard EDA simulators and timing analyzers, or with the timing model shown in Figure 3-2.

MAX V devices have predictable internal delays that allow you to determine the worst-case timing of any design. The software provides timing simulation, point-to-point delay prediction, and detailed timing analysis for device-wide performance evaluation.

Figure 3-2. Timing Model for MAX V Devices



You can derive the timing characteristics of any signal path from the timing model and parameters of a particular device. You can calculate external timing parameters, which represent pin-to-pin timing delays, as the sum of the internal parameters.

For more information, refer to AN629: *Understanding Timing in Altera CPLDs*.

Preliminary and Final Timing

This section describes the performance, internal, external, and UFM timing specifications. All specifications are representative of the worst-case supply voltage and junction temperature conditions.

Timing models can have either preliminary or final status. The Quartus II software issues an informational message during the design compilation if the timing models are preliminary. Table 3–16 lists the status of the MAX V device timing models.

Preliminary status means the timing model is subject to change. Initially, timing numbers are created using simulation results, process data, and other known parameters. These tests are used to make the preliminary numbers as close to the actual timing parameters as possible.

Final timing numbers are based on actual device operation and testing. These numbers reflect the actual performance of the device under the worst-case voltage and junction temperature conditions.

Table 3–16. Timing Model Status for MAX V Devices

Device	Final
5M40Z	✓
5M80Z	✓
5M160Z	✓
5M240Z	✓
5M570Z	✓
5M1270Z	✓
5M2210Z	✓

Performance

Table 3–17 lists the MAX V device performance for some common designs. All performance values were obtained with the Quartus II software compilation of megafunctions.

Table 3–17. Device Performance for MAX V Devices (Part 1 of 2)

Resource Used	Design Size and Function	Resources Used			Performance				Unit
					5M40Z/ 5M80Z/ 5M160Z/ 5M240Z/ 5M570Z		5M1270Z/ 5M2210Z		
		Mode	LEs	UFM Blocks	C4	C5, I5	C4	C5, I5	
LE	16-bit counter (1)	—	16	0	184.1	118.3	247.5	201.1	MHz
	64-bit counter (1)	—	64	0	83.2	80.5	154.8	125.8	MHz
	16-to-1 multiplexer	—	11	0	17.4	20.4	8.0	9.3	ns
	32-to-1 multiplexer	—	24	0	12.5	25.3	9.0	11.4	ns
	16-bit XOR function	—	5	0	9.0	16.1	6.6	8.2	ns
	16-bit decoder with single address line	—	5	0	9.2	16.1	6.6	8.2	ns

Table 3–20 through Table 3–23 list the adder delays for t_{ZX} and t_{XZ} microparameters when using an I/O standard other than 3.3-V LVTTTL with 16 mA drive strength.

Table 3–20. t_{ZX} IOE Microparameter Adders for Fast Slew Rate for MAX V Devices

Standard		5M40Z/ 5M80Z/ 5M160Z/ 5M240Z/ 5M570Z				5M1270Z/ 5M2210Z				Unit
		C4		C5, I5		C4		C5, I5		
		Min	Max	Min	Max	Min	Max	Min	Max	
3.3-V LV TTL	16 mA	—	0	—	0	—	0	—	0	ps
	8 mA	—	72	—	74	—	101	—	125	ps
3.3-V LV CMOS	8 mA	—	0	—	0	—	0	—	0	ps
	4 mA	—	72	—	74	—	101	—	125	ps
2.5-V LV TTL / LV CMOS	14 mA	—	126	—	127	—	155	—	191	ps
	7 mA	—	196	—	197	—	545	—	671	ps
1.8-V LV TTL / LV CMOS	6 mA	—	608	—	610	—	721	—	888	ps
	3 mA	—	681	—	685	—	2012	—	2477	ps
1.5-V LV CMOS	4 mA	—	1162	—	1157	—	1590	—	1957	ps
	2 mA	—	1245	—	1244	—	3269	—	4024	ps
1.2-V LV CMOS	3 mA	—	1889	—	1856	—	2860	—	3520	ps
3.3-V PCI	20 mA	—	72	—	74	—	–18	—	–22	ps
LVDS	—	—	126	—	127	—	155	—	191	ps
RSDS	—	—	126	—	127	—	155	—	191	ps

Table 3–21. t_{ZX} IOE Microparameter Adders for Slow Slew Rate for MAX V Devices

Standard		5M40Z/ 5M80Z/ 5M160Z/ 5M240Z/ 5M570Z				5M1270Z/ 5M2210Z				Unit
		C4		C5, I5		C4		C5, I5		
		Min	Max	Min	Max	Min	Max	Min	Max	
3.3-V LV TTL	16 mA	—	5,951	—	6,063	—	6,012	—	5,743	ps
	8 mA	—	6,534	—	6,662	—	8,785	—	8,516	ps
3.3-V LV CMOS	8 mA	—	5,951	—	6,063	—	6,012	—	5,743	ps
	4 mA	—	6,534	—	6,662	—	8,785	—	8,516	ps
2.5-V LV TTL / LV CMOS	14 mA	—	9,110	—	9,237	—	10,072	—	9,803	ps
	7 mA	—	9,830	—	9,977	—	12,945	—	12,676	ps
1.8-V LV TTL / LV CMOS	6 mA	—	21,800	—	21,787	—	21,185	—	20,916	ps
	3 mA	—	23,020	—	23,037	—	24,597	—	24,328	ps
1.5-V LV CMOS	4 mA	—	39,120	—	39,067	—	34,517	—	34,248	ps
	2 mA	—	40,670	—	40,617	—	39,717	—	39,448	ps
1.2-V LV CMOS	3 mA	—	69,505	—	70,461	—	55,800	—	55,531	ps
3.3-V PCI	20 mA	—	6,534	—	6,662	—	35	—	44	ps

Table 3–22. t_{xz} IOE Microparameter Adders for Fast Slew Rate for MAX V Devices

Standard		5M40Z/ 5M80Z/ 5M160Z/ 5M240Z/ 5M570Z				5M1270Z/ 5M2210Z				Unit
		C4		C5, I5		C4		C5, I5		
		Min	Max	Min	Max	Min	Max	Min	Max	
3.3-V LVTTTL	16 mA	—	0	—	0	—	0	—	0	ps
	8 mA	—	–69	—	–69	—	–74	—	–91	ps
3.3-V LVCMOS	8 mA	—	0	—	0	—	0	—	0	ps
	4 mA	—	–69	—	–69	—	–74	—	–91	ps
2.5-V LVTTTL / LVCMOS	14 mA	—	–7	—	–10	—	–46	—	–56	ps
	7 mA	—	–66	—	–69	—	–82	—	–101	ps
1.8-V LVTTTL / LVCMOS	6 mA	—	45	—	37	—	–7	—	–8	ps
	3 mA	—	34	—	25	—	119	—	147	ps
1.5-V LVCMOS	4 mA	—	166	—	155	—	339	—	418	ps
	2 mA	—	190	—	179	—	464	—	571	ps
1.2-V LVCMOS	3 mA	—	300	—	283	—	817	—	1,006	ps
3.3-V PCI	20 mA	—	–69	—	–69	—	80	—	99	ps
LVDS	—	—	–7	—	–10	—	–46	—	–56	ps
RSDS	—	—	–7	—	–10	—	–46	—	–56	ps

Table 3–23. t_{xz} IOE Microparameter Adders for Slow Slew Rate for MAX V Devices

Standard		5M40Z/ 5M80Z/ 5M160Z/ 5M240Z/ 5M570Z				5M1270Z/ 5M2210Z				Unit
		C4		C5, I5		C4		C5, I5		
		Min	Max	Min	Max	Min	Max	Min	Max	
3.3-V LV TTL	16 mA	—	171	—	174	—	73	—	–132	ps
	8 mA	—	112	—	116	—	758	—	553	ps
3.3-V LV CMOS	8 mA	—	171	—	174	—	73	—	–132	ps
	4 mA	—	112	—	116	—	758	—	553	ps
2.5-V LV TTL / LV CMOS	14 mA	—	213	—	213	—	32	—	–173	ps
	7 mA	—	166	—	166	—	714	—	509	ps
1.8-V LV TTL / LV CMOS	6 mA	—	441	—	438	—	96	—	–109	ps
	3 mA	—	496	—	494	—	963	—	758	ps
1.5-V LV CMOS	4 mA	—	765	—	755	—	238	—	33	ps
	2 mA	—	903	—	897	—	1,319	—	1,114	ps
1.2-V LV CMOS	3 mA	—	1,159	—	1,130	—	400	—	195	ps
3.3-V PCI	20 mA	—	112	—	116	—	303	—	373	ps



The default slew rate setting for MAX V devices in the Quartus II design software is “fast”.

Table 3-24. UFM Block Internal Timing Microparameters for MAX V Devices (Part 1 of 2)

Symbol	Parameter	5M40Z/ 5M80Z/ 5M160Z/ 5M240Z/ 5M570Z				5M1270Z/ 5M2210Z				Unit
		C4		C5, I5		C4		C5, I5		
		Min	Max	Min	Max	Min	Max	Min	Max	
t _{ACLK}	Address register clock period	100	—	100	—	100	—	100	—	ns
t _{ASU}	Address register shift signal setup to address register clock	20	—	20	—	20	—	20	—	ns
t _{AH}	Address register shift signal hold to address register clock	20	—	20	—	20	—	20	—	ns
t _{ADS}	Address register data in setup to address register clock	20	—	20	—	20	—	20	—	ns
t _{ADH}	Address register data in hold from address register clock	20	—	20	—	20	—	20	—	ns
t _{DCLK}	Data register clock period	100	—	100	—	100	—	100	—	ns
t _{DSS}	Data register shift signal setup to data register clock	60	—	60	—	60	—	60	—	ns
t _{DSH}	Data register shift signal hold from data register clock	20	—	20	—	20	—	20	—	ns
t _{DDS}	Data register data in setup to data register clock	20	—	20	—	20	—	20	—	ns
t _{DDH}	Data register data in hold from data register clock	20	—	20	—	20	—	20	—	ns
t _{DP}	Program signal to data clock hold time	0	—	0	—	0	—	0	—	ns
t _{PB}	Maximum delay between program rising edge to UFM _{busy} signal rising edge	—	960	—	960	—	960	—	960	ns
t _{BP}	Minimum delay allowed from UFM _{busy} signal going low to program signal going low	20	—	20	—	20	—	20	—	ns
t _{PPMX}	Maximum length of busy pulse during a program	—	100	—	100	—	100	—	100	μs

Table 3–24. UFM Block Internal Timing Microparameters for MAX V Devices (Part 2 of 2)

Symbol	Parameter	5M40Z/ 5M80Z/ 5M160Z/ 5M240Z/ 5M570Z				5M1270Z/ 5M2210Z				Unit
		C4		C5, I5		C4		C5, I5		
		Min	Max	Min	Max	Min	Max	Min	Max	
t _{AE}	Minimum <i>erase</i> signal to address clock hold time	0	—	0	—	0	—	0	—	ns
t _{EB}	Maximum delay between the <i>erase</i> rising edge to the UFM <i>busy</i> signal rising edge	—	960	—	960	—	960	—	960	ns
t _{BE}	Minimum delay allowed from the UFM <i>busy</i> signal going low to <i>erase</i> signal going low	20	—	20	—	20	—	20	—	ns
t _{EPMX}	Maximum length of <i>busy</i> pulse during an <i>erase</i>	—	500	—	500	—	500	—	500	ms
t _{DCO}	Delay from data register clock to data register output	—	5	—	5	—	5	—	5	ns
t _{OE}	Delay from OSC_ENA signal reaching UFM to rising clock of OSC leaving the UFM	180	—	180	—	180	—	180	—	ns
t _{RA}	Maximum read access time	—	65	—	65	—	65	—	65	ns
t _{OSCS}	Maximum delay between the OSC_ENA rising edge to the <i>erase</i> /program signal rising edge	250	—	250	—	250	—	250	—	ns
t _{OSCH}	Minimum delay allowed from the <i>erase</i> /program signal going low to OSC_ENA signal going low	250	—	250	—	250	—	250	—	ns

Figure 3-3 through Figure 3-5 show the read, program, and erase waveforms for UFM block timing parameters listed in Table 3-24.

Figure 3-3. UFM Read Waveform

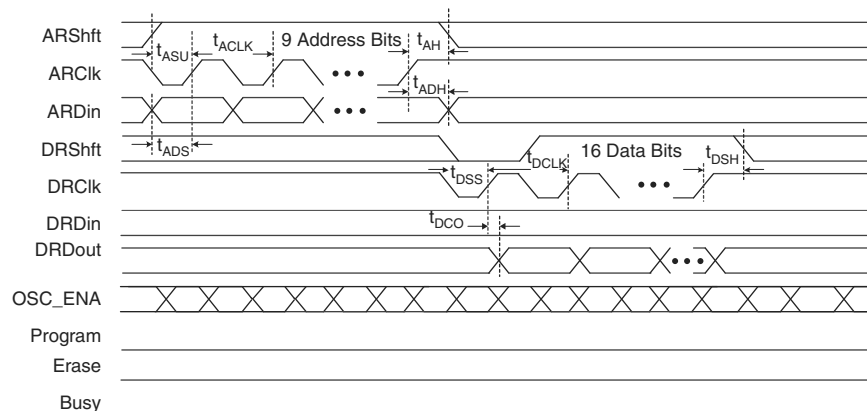


Figure 3-4. UFM Program Waveform

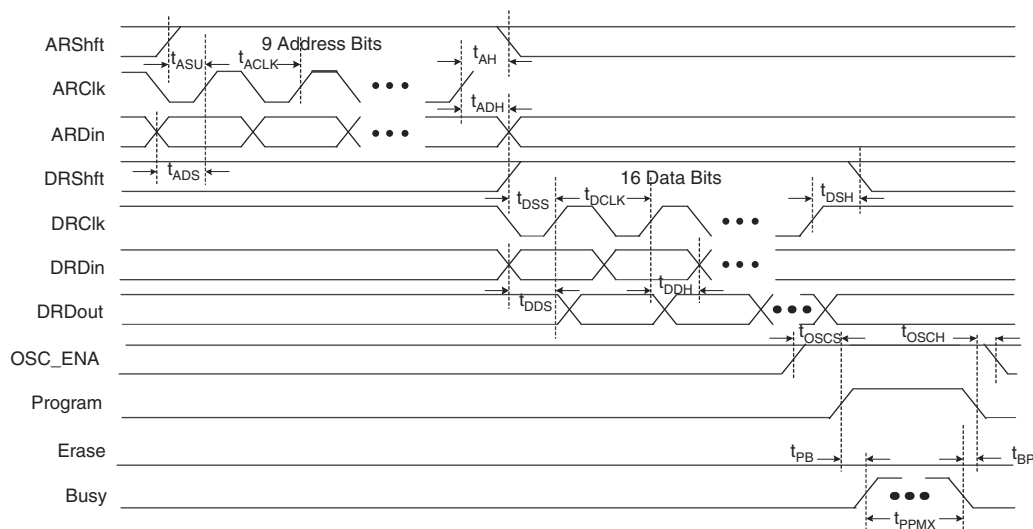


Figure 3-5. UFM Erase Waveform

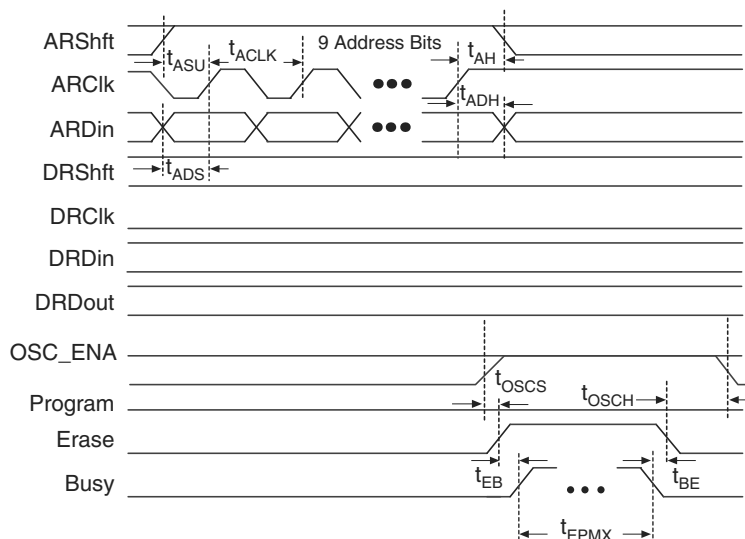


Table 3-25. Routing Delay Internal Timing Microparameters for MAX V Devices

Routing	5M40Z/ 5M80Z/ 5M160Z/ 5M240Z/ 5M570Z				5M1270Z/ 5M2210Z				Unit
	C4		C5, I5		C4		C5, I5		
	Min	Max	Min	Max	Min	Max	Min	Max	
t _{C4}	—	860	—	1,973	—	561	—	690	ps
t _{R4}	—	655	—	1,479	—	445	—	548	ps
t _{LOCAL}	—	1,143	—	2,947	—	731	—	899	ps

External Timing Parameters

External timing parameters are specified by device density and speed grade. All external I/O timing parameters shown are for the 3.3-V LVTTTL I/O standard with the maximum drive strength and fast slew rate. For external I/O timing using standards other than LVTTTL or for different drive strengths, use the I/O standard input and output delay adders in Table 3-32 on page 3-23 through Table 3-36 on page 3-25.

For more information about each external timing parameters symbol, refer to AN629: *Understanding Timing in Altera CPLDs*.

Table 3–26 lists the external I/O timing parameters for the 5M40Z, 5M80Z, 5M160Z, and 5M240Z devices.

Table 3–26. Global Clock External I/O Timing Parameters for the 5M40Z, 5M80Z, 5M160Z, and 5M240Z Devices (Note 1), (2)

Symbol	Parameter	Condition	C4		C5, I5		Unit
			Min	Max	Min	Max	
t_{PD1}	Worst case pin-to-pin delay through one LUT	10 pF	—	7.9	—	14.0	ns
t_{PD2}	Best case pin-to-pin delay through one LUT	10 pF	—	5.8	—	8.5	ns
t_{SU}	Global clock setup time	—	2.4	—	4.6	—	ns
t_H	Global clock hold time	—	0	—	0	—	ns
t_{CO}	Global clock to output delay	10 pF	2.0	6.6	2.0	8.6	ns
t_{CH}	Global clock high time	—	253	—	339	—	ps
t_{CL}	Global clock low time	—	253	—	339	—	ps
t_{CNT}	Minimum global clock period for 16-bit counter	—	5.4	—	8.4	—	ns
f_{CNT}	Maximum global clock frequency for 16-bit counter	—	—	184.1	—	118.3	MHz

Notes to Table 3–26:

- (1) The maximum frequency is limited by the I/O standard on the clock input pin. The 16-bit counter critical delay performs faster than this global clock input pin maximum frequency.
- (2) Not applicable to the T144 package of the 5M240Z device.

Table 3–27 lists the external I/O timing parameters for the T144 package of the 5M240Z device.

Table 3–27. Global Clock External I/O Timing Parameters for the 5M240Z Device (Note 1), (2)

Symbol	Parameter	Condition	C4		C5, I5		Unit
			Min	Max	Min	Max	
t_{PD1}	Worst case pin-to-pin delay through one LUT	10 pF	—	9.5	—	17.7	ns
t_{PD2}	Best case pin-to-pin delay through one LUT	10 pF	—	5.7	—	8.5	ns
t_{SU}	Global clock setup time	—	2.2	—	4.4	—	ns
t_H	Global clock hold time	—	0	—	0	—	ns
t_{CO}	Global clock to output delay	10 pF	2.0	6.7	2.0	8.7	ns
t_{CH}	Global clock high time	—	253	—	339	—	ps
t_{CL}	Global clock low time	—	253	—	339	—	ps
t_{CNT}	Minimum global clock period for 16-bit counter	—	5.4	—	8.4	—	ns
f_{CNT}	Maximum global clock frequency for 16-bit counter	—	—	184.1	—	118.3	MHz

Notes to Table 3–27:

- (1) The maximum frequency is limited by the I/O standard on the clock input pin. The 16-bit counter critical delay performs faster than this global clock input pin maximum frequency.
- (2) Only applicable to the T144 package of the 5M240Z device.

External Timing I/O Delay Adders

The I/O delay timing parameters for the I/O standard input and output adders and the input delays are specified by speed grade, independent of device density.

Table 3–32 through Table 3–36 on page 3–25 list the adder delays associated with I/O pins for all packages. If you select an I/O standard other than 3.3-V LVTTL, add the input delay adder to the external t_{SU} timing parameters listed in Table 3–26 on page 3–20 through Table 3–31. If you select an I/O standard other than 3.3-V LVTTL with 16 mA drive strength and fast slew rate, add the output delay adder to the external t_{CO} and t_{PD} listed in Table 3–26 on page 3–20 through Table 3–31.

Table 3–32. External Timing Input Delay Adders for MAX V Devices

I/O Standard		5M40Z/ 5M80Z/ 5M160Z/ 5M240Z/ 5M570Z				5M1270Z/ 5M2210Z				Unit
		C4		C5, I5		C4		C5, I5		
		Min	Max	Min	Max	Min	Max	Min	Max	
3.3-V LVTTL	Without Schmitt Trigger	—	0	—	0	—	0	—	0	ps
	With Schmitt Trigger	—	387	—	442	—	480	—	591	ps
3.3-V LVCMOS	Without Schmitt Trigger	—	0	—	0	—	0	—	0	ps
	With Schmitt Trigger	—	387	—	442	—	480	—	591	ps
2.5-V LVTTL / LVCMOS	Without Schmitt Trigger	—	42	—	42	—	246	—	303	ps
	With Schmitt Trigger	—	429	—	483	—	787	—	968	ps
1.8-V LVTTL / LVCMOS	Without Schmitt Trigger	—	378	—	368	—	695	—	855	ps
1.5-V LVCMOS	Without Schmitt Trigger	—	681	—	658	—	1,334	—	1,642	ps
1.2-V LVCMOS	Without Schmitt Trigger	—	1,055	—	1,010	—	2,324	—	2,860	ps
3.3-V PCI	Without Schmitt Trigger	—	0	—	0	—	0	—	0	ps

Table 3–33. External Timing Input Delay t_{GLOB} Adders for GCLK Pins for MAX V Devices (Part 1 of 2)

I/O Standard		5M40Z/ 5M80Z/ 5M160Z/ 5M240Z/ 5M570Z				5M1270Z/ 5M2210Z				Unit
		C4		C5, I5		C4		C5, I5		
		Min	Max	Min	Max	Min	Max	Min	Max	
3.3-V LVTTL	Without Schmitt Trigger	—	0	—	0	—	0	—	0	ps
	With Schmitt Trigger	—	387	—	442	—	400	—	493	ps

Table 3–35. External Timing Output Delay and t_{OD} Adders for Slow Slew Rate for MAX V Devices

I/O Standard		5M40Z/ 5M80Z/ 5M160Z/ 5M240Z/ 5M570Z				5M1270Z/ 5M2210Z				Unit
		C4		C5, I5		C4		C5, I5		
		Min	Max	Min	Max	Min	Max	Min	Max	
3.3-V LVTTTL	16 mA	—	5,913	—	6,043	—	6,612	—	6,293	ps
	8 mA	—	6,488	—	6,645	—	7,313	—	6,994	ps
3.3-V LVCMOS	8 mA	—	5,913	—	6,043	—	6,612	—	6,293	ps
	4 mA	—	6,488	—	6,645	—	7,313	—	6,994	ps
2.5-V LVTTTL / LVCMOS	14 mA	—	9,088	—	9,222	—	10,021	—	9,702	ps
	7 mA	—	9,808	—	9,962	—	10,881	—	10,562	ps
1.8-V LVTTTL / LVCMOS	6 mA	—	21,758	—	21,782	—	21,134	—	20,815	ps
	3 mA	—	23,028	—	23,032	—	22,399	—	22,080	ps
1.5-V LVCMOS	4 mA	—	39,068	—	39,032	—	34,499	—	34,180	ps
	2 mA	—	40,578	—	40,542	—	36,281	—	35,962	ps
1.2-V LVCMOS	3 mA	—	69,332	—	70,257	—	55,796	—	55,477	ps
3.3-V PCI	20 mA	—	6,488	—	6,645	—	339	—	418	ps

Table 3–36. IOE Programmable Delays for MAX V Devices

Parameter	5M40Z/ 5M80Z/ 5M160Z/ 5M240Z/ 5M570Z				5M1270Z/ 5M2210Z				Unit
	C4		C5, I5		C4		C5, I5		
	Min	Max	Min	Max	Min	Max	Min	Max	
Input Delay from Pin to Internal Cells = 1	—	1,858	—	2,214	—	1,592	—	1,960	ps
Input Delay from Pin to Internal Cells = 0	—	569	—	616	—	115	—	142	ps

Table 3–40 lists the emulated RSDS output timing specifications for MAX V devices.

Table 3–40. Emulated RSDS Output Timing Specifications for MAX V Devices

Parameter	Mode	5M40Z/ 5M80Z/ 5M160Z/ 5M240Z/ 5M570Z/5M1270Z/ 5M2210Z		Unit
		C4, C5, I5		
		Min	Max	
Data rate (1)	×10	—	200	Mbps
	×9	—	200	Mbps
	×8	—	200	Mbps
	×7	—	200	Mbps
	×6	—	200	Mbps
	×5	—	200	Mbps
	×4	—	200	Mbps
	×3	—	200	Mbps
	×2	—	200	Mbps
	×1	—	200	Mbps
t _{DUTY}	—	45	55	%
Total jitter (2)	—	—	0.2	UI
t _{RISE}	—	—	450	ps
t _{FALL}	—	—	450	ps

Notes to Table 3–40:

- (1) For the input clock pin to achieve 200 Mbps, use I/O standard with V_{CCIO} of 1.8 V and above.
- (2) This specification is based on external clean clock source.

JTAG Timing Specifications

Figure 3–6 shows the timing waveform for the JTAG signals for the MAX V device family.

Figure 3–6. JTAG Timing Waveform for MAX V Devices

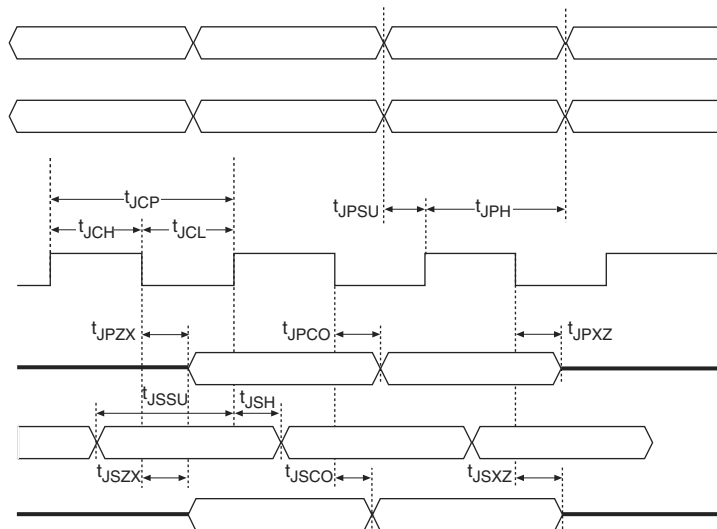


Table 3–41 lists the JTAG timing parameters and values for the MAX V device family.

Table 3–41. JTAG Timing Parameters for MAX V Devices (Part 1 of 2)

Symbol	Parameter	Min	Max	Unit
t_{JCP} (1)	TCK clock period for $V_{CCIO1} = 3.3\text{ V}$	55.5	—	ns
	TCK clock period for $V_{CCIO1} = 2.5\text{ V}$	62.5	—	ns
	TCK clock period for $V_{CCIO1} = 1.8\text{ V}$	100	—	ns
	TCK clock period for $V_{CCIO1} = 1.5\text{ V}$	143	—	ns
t_{JCH}	TCK clock high time	20	—	ns
t_{JCL}	TCK clock low time	20	—	ns
t_{JPSU}	JTAG port setup time (2)	8	—	ns
t_{JPH}	JTAG port hold time	10	—	ns
t_{JPCO}	JTAG port clock to output (2)	—	15	ns
t_{JPZX}	JTAG port high impedance to valid output (2)	—	15	ns
t_{JPXZ}	JTAG port valid output to high impedance (2)	—	15	ns
t_{JSSU}	Capture register setup time	8	—	ns
t_{JSH}	Capture register hold time	10	—	ns
t_{JSCO}	Update register clock to output	—	25	ns
t_{JSZX}	Update register high impedance to valid output	—	25	ns