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Understanding Embedded - FPGAs (Field Programmable Gate Array)

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

Applications of Embedded - FPGAs

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

Details

Product Status	Obsolete
Number of LABs/CLBs	360
Number of Logic Elements/Cells	2880
Total RAM Bits	20480
Number of I/O	189
Number of Gates	116000
Voltage - Supply	3V ~ 3.6V
Mounting Type	Surface Mount
Operating Temperature	-40°C ~ 85°C (TA)
Package / Case	240-BFQFP Exposed Pad
Supplier Device Package	240-RQFP (32x32)
Purchase URL	https://www.e-xfl.com/product-detail/intel/epf10k50vri240-4n

Table 4. FLEX 10K Package Options & I/O Pin Count *Note (1)*

Device	84-Pin PLCC	100-Pin TQFP	144-Pin TQFP	208-Pin PQFP RQFP	240-Pin PQFP RQFP
EPF10K10	59		102	134	
EPF10K10A		66	102	134	
EPF10K20			102	147	189
EPF10K30				147	189
EPF10K30A			102	147	189
EPF10K40				147	189
EPF10K50					189
EPF10K50V					189
EPF10K70					189
EPF10K100					
EPF10K100A					189
EPF10K130V					
EPF10K250A					

Table 5. FLEX 10K Package Options & I/O Pin Count (Continued) *Note (1)*

Device	503-Pin PGA	599-Pin PGA	256-Pin FineLine BGA	356-Pin BGA	484-Pin FineLine BGA	600-Pin BGA	403-Pin PGA
EPF10K10							
EPF10K10A			150		150 *(2)*		
EPF10K20							
EPF10K30				246			
EPF10K30A			191	246	246		
EPF10K40							
EPF10K50				274			310
EPF10K50V				274			
EPF10K70	358						
EPF10K100	406						
EPF10K100A				274	369	406	
EPF10K130V		470				470	
EPF10K250A		470				470	

Altera Corporation

Notes to tables:
(1) FLEX 10K and FLEX 10KA device package types include plastic J-lead chip carrier (PLCC), thin quad flat pack (TQFP), plastic quad flat pack (PQFP), power quad flat pack (RQFP), ball-grid array (BGA), pin-grid array (PGA), and FineLine BGA™ packages.
(2) This option is supported with a 256-pin FineLine BGA package. By using SameFrame pin migration, all FineLine BGA packages are pin compatible. For example, a board can be designed to support both 256-pin and 484-pin FineLine BGA packages. The Altera software automatically avoids conflicting pins when future migration is set.

General Description

Altera's FLEX 10K devices are the industry's first embedded PLDs. Based on reconfigurable CMOS SRAM elements, the Flexible Logic Element MatriX (FLEX) architecture incorporates all features necessary to implement common gate array megafunctions. With up to 250,000 gates, the FLEX 10K family provides the density, speed, and features to integrate entire systems, including multiple 32-bit buses, into a single device.

FLEX 10K devices are reconfigurable, which allows 100% testing prior to shipment. As a result, the designer is not required to generate test vectors for fault coverage purposes. Additionally, the designer does not need to manage inventories of different ASIC designs; FLEX 10K devices can be configured on the board for the specific functionality required.

Table 6 shows FLEX 10K performance for some common designs. All performance values were obtained with Synopsys DesignWare or LPM functions. No special design technique was required to implement the applications; the designer simply inferred or instantiated a function in a Verilog HDL, VHDL, Altera Hardware Description Language (AHDL), or schematic design file.

Table 6. FLEX 10K & FLEX 10KA Performance

Application	Resources Used		Performance				Units
	LEs	EABs	-1 Speed Grade	-2 Speed Grade	-3 Speed Grade	-4 Speed Grade	
16-bit loadable counter (1)	16	0	204	166	125	95	MHz
16-bit accumulator (1)	16	0	204	166	125	95	MHz
16-to-1 multiplexer (2)	10	0	4.2	5.8	6.0	7.0	ns
256 × 8 RAM read cycle speed (3)	0	1	172	145	108	84	MHz
256 × 8 RAM write cycle speed (3)	0	1	106	89	68	63	MHz

Notes:
(1) The speed grade of this application is limited because of clock high and low specifications.
(2) This application uses combinatorial inputs and outputs.
(3) This application uses registered inputs and outputs.

The programmable flipflop in the LE can be configured for D, T, JK, or SR operation. The clock, clear, and preset control signals on the flipflop can be driven by global signals, general-purpose I/O pins, or any internal logic. For combinatorial functions, the flipflop is bypassed and the output of the LUT drives the output of the LE.

The LE has two outputs that drive the interconnect; one drives the local interconnect and the other drives either the row or column FastTrack Interconnect. The two outputs can be controlled independently. For example, the LUT can drive one output while the register drives the other output. This feature, called register packing, can improve LE utilization because the register and the LUT can be used for unrelated functions.

The FLEX 10K architecture provides two types of dedicated high-speed data paths that connect adjacent LEs without using local interconnect paths: carry chains and cascade chains. The carry chain supports high-speed counters and adders; the cascade chain implements wide-input functions with minimum delay. Carry and cascade chains connect all LEs in an LAB and all LABs in the same row. Intensive use of carry and cascade chains can reduce routing flexibility. Therefore, the use of these chains should be limited to speed-critical portions of a design.

Carry Chain

The carry chain provides a very fast (as low as 0.2 ns) carry-forward function between LEs. The carry-in signal from a lower-order bit drives forward into the higher-order bit via the carry chain, and feeds into both the LUT and the next portion of the carry chain. This feature allows the FLEX 10K architecture to implement high-speed counters, adders, and comparators of arbitrary width efficiently. Carry chain logic can be created automatically by the Compiler during design processing, or manually by the designer during design entry. Parameterized functions such as LPM and DesignWare functions automatically take advantage of carry chains.

Carry chains longer than eight LEs are automatically implemented by linking LABs together. For enhanced fitting, a long carry chain skips alternate LABs in a row. A carry chain longer than one LAB skips either from even-numbered LAB to even-numbered LAB, or from odd-numbered LAB to odd-numbered LAB. For example, the last LE of the first LAB in a row carries to the first LE of the third LAB in the row. The carry chain does not cross the EAB at the middle of the row. For instance, in the EPF10K50 device, the carry chain stops at the eighteenth LAB and a new one begins at the nineteenth LAB.
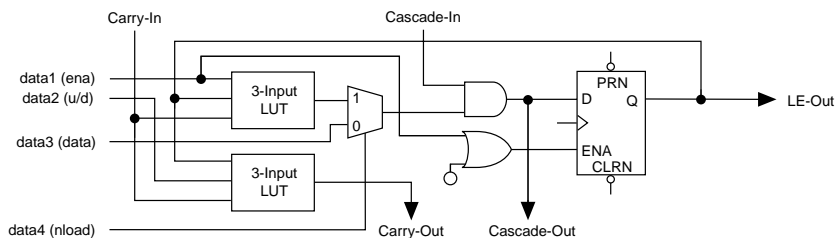
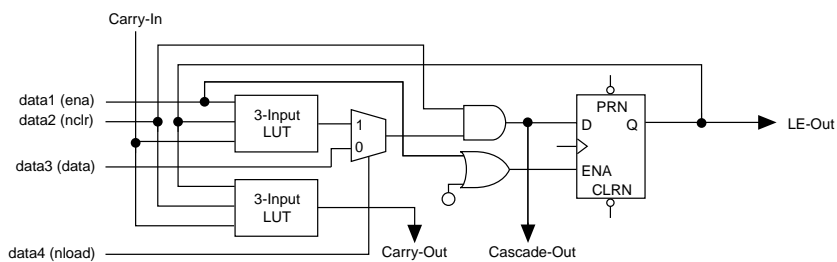## Figure 9. FLEX 10K LE Operating Modes

Normal Mode
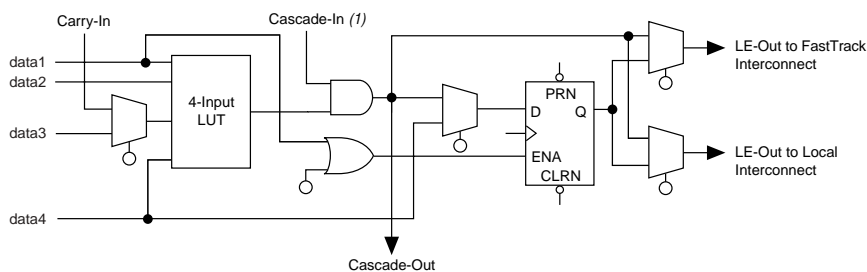
Arithmetic Mode
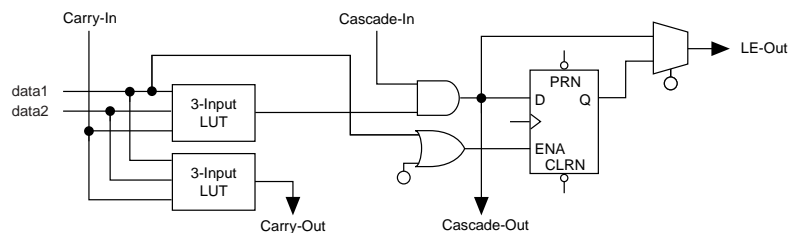
Up/Down Counter Mode

Clearable Counter Mode

Note:
(1)   Packed registers cannot be used with the cascade chain.

Each IOE selects the clock, clear, clock enable, and output enable controls from a network of I/O control signals called the peripheral control bus. The peripheral control bus uses high-speed drivers to minimize signal skew across devices; it provides up to 12 peripheral control signals that can be allocated as follows:

- Up to eight output enable signals
- Up to six clock enable signals
- Up to two clock signals
- Up to two clear signals

If more than six clock enable or eight output enable signals are required, each IOE on the device can be controlled by clock enable and output enable signals driven by specific LEs. In addition to the two clock signals available on the peripheral control bus, each IOE can use one of two dedicated clock pins. Each peripheral control signal can be driven by any of the dedicated input pins or the first LE of each LAB in a particular row. In addition, an LE in a different row can drive a column interconnect, which causes a row interconnect to drive the peripheral control signal. The chip-wide reset signal will reset all IOE registers, overriding any other control signals.

Tables 8 and 9 list the sources for each peripheral control signal, and the rows that can drive global signals. These tables also show how the output enable, clock enable, clock, and clear signals share 12 peripheral control signals.

ClockLock & ClockBoost Features

To support high-speed designs, selected FLEX 10K devices offer optional ClockLock and ClockBoost circuitry containing a phase-locked loop (PLL) that is used to increase design speed and reduce resource usage. The ClockLock circuitry uses a synchronizing PLL that reduces the clock delay and skew within a device. This reduction minimizes clock-to-output and setup times while maintaining zero hold times. The ClockBoost circuitry, which provides a clock multiplier, allows the designer to enhance device area efficiency by sharing resources within the device. The ClockBoost feature allows the designer to distribute a low-speed clock and multiply that clock on-device. Combined, the ClockLock and ClockBoost features provide significant improvements in system performance and bandwidth.

The ClockLock and ClockBoost features in FLEX 10K devices are enabled through the Altera software. External devices are not required to use these features. The output of the ClockLock and ClockBoost circuits is not available at any of the device pins.

The ClockLock and ClockBoost circuitry locks onto the rising edge of the incoming clock. The circuit output can only drive the clock inputs of registers; the generated clock cannot be gated or inverted.

The dedicated clock pin (GCLK1) supplies the clock to the ClockLock and ClockBoost circuitry. When the dedicated clock pin is driving the ClockLock or ClockBoost circuitry, it cannot drive elsewhere in the device.

In designs that require both a multiplied and non-multiplied clock, the clock trace on the board can be connected to GCLK1. With the Altera software, GCLK1 can feed both the ClockLock and ClockBoost circuitry in the FLEX 10K device. However, when both circuits are used, the other clock pin (GCLK0) cannot be used. Figure 17 shows a block diagram of how to enable both the ClockLock and ClockBoost circuits in the Altera software. The example shown is a schematic, but a similar approach applies for designs created in AHDL, VHDL, and Verilog HDL. When the ClockLock and ClockBoost circuits are used simultaneously, the input frequency parameter must be the same for both circuits. In Figure 17, the input frequency must meet the requirements specified when the ClockBoost multiplication factor is two.

Table 18. FLEX 10K 5.0-V Device Recommended Operating Conditions

Symbol	Parameter	Conditions	Min	Max	Unit
V_{CCINT}	Supply voltage for internal logic and input buffers	*(3)*, *(4)*	4.75 (4.50)	5.25 (5.50)	V
V_{CCIO}	Supply voltage for output buffers, 5.0-V operation	*(3)*, *(4)*	4.75 (4.50)	5.25 (5.50)	V
	Supply voltage for output buffers, 3.3-V operation	*(3)*, *(4)*	3.00 (3.00)	3.60 (3.60)	V
V_I	Input voltage		−0.5	V_{CCINT} + 0.5	V
V_O	Output voltage		0	V_{CCIO}	V
T_A	Ambient temperature	For commercial use	0	70	°C
		For industrial use	−40	85	°C
T_J	Operating temperature	For commercial use	0	85	°C
		For industrial use	−40	100	°C
t_R	Input rise time			40	ns
t_F	Input fall time			40	ns

Table 29. 3.3-V Device Capacitance of EPF10K10A & EPF10K30A Devices *Note (12)*

Symbol	Parameter	Conditions	Min	Max	Unit
C_{IN}	Input capacitance	V_{IN} = 0 V, f = 1.0 MHz		8	pF
C_{INCLK}	Input capacitance on dedicated clock pin	V_{IN} = 0 V, f = 1.0 MHz		12	pF
C_{OUT}	Output capacitance	V_{OUT} = 0 V, f = 1.0 MHz		8	pF

Table 30. 3.3-V Device Capacitance of EPF10K100A Devices *Note (12)*

Symbol	Parameter	Conditions	Min	Max	Unit
C_{IN}	Input capacitance	V_{IN} = 0 V, f = 1.0 MHz		10	pF
C_{INCLK}	Input capacitance on dedicated clock pin	V_{IN} = 0 V, f = 1.0 MHz		15	pF
C_{OUT}	Output capacitance	V_{OUT} = 0 V, f = 1.0 MHz		10	pF

Table 31. 3.3-V Device Capacitance of EPF10K250A Devices *Note (12)*

Symbol	Parameter	Conditions	Min	Max	Unit
C_{IN}	Input capacitance	V_{IN} = 0 V, f = 1.0 MHz		10	pF
C_{INCLK}	Input capacitance on dedicated clock pin	V_{IN} = 0 V, f = 1.0 MHz		15	pF
C_{OUT}	Output capacitance	V_{OUT} = 0 V, f = 1.0 MHz		10	pF

Notes to tables:
(1) See the *Operating Requirements for Altera Devices Data Sheet*.
(2) Minimum DC voltage input is –0.5 V. During transitions, the inputs may undershoot to –2.0 V or overshoot to 5.75 V for input currents less than 100 mA and periods shorter than 20 ns.
(3) Numbers in parentheses are for industrial-temperature-range devices.
(4) Maximum V_{CC} rise time is 100 ms, and V_{CC} must rise monotonically.
(5) FLEX 10KA device inputs may be driven before V_{CCINT} and V_{CCIO} are powered.
(6) Typical values are for T_A = 25° C and V_{CC} = 3.3 V.
(7) These values are specified under the Recommended Operating Conditions shown in Table 27 on page 51.
(8) The I_{OH} parameter refers to high-level TTL, PCI, or CMOS output current.
(9) The I_{OL} parameter refers to low-level TTL, PCI, or CMOS output current. This parameter applies to open-drain pins as well as output pins.
(10) This value is specified for normal device operation. The value may vary during power-up.
(11) This parameter applies to all -1 speed grade commercial temperature devices and all -2 speed grade industrial-temperature devices.
(12) Capacitance is sample-tested only.

Figure 23. Output Drive Characteristics for EPF10K250A Device
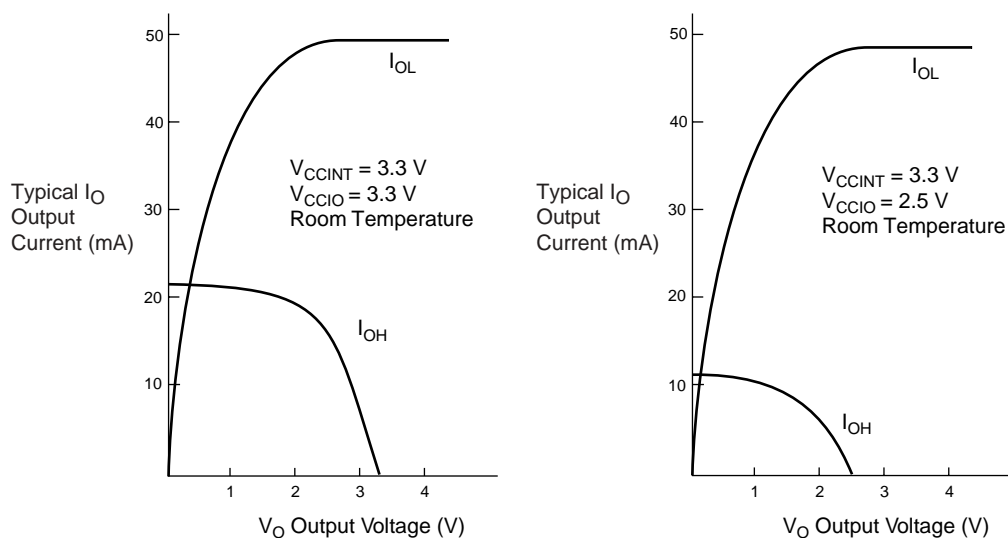
Timing Model

The continuous, high-performance FastTrack Interconnect routing resources ensure predictable performance and accurate simulation and timing analysis. This predictable performance contrasts with that of FPGAs, which use a segmented connection scheme and therefore have unpredictable performance.

Device performance can be estimated by following the signal path from a source, through the interconnect, to the destination. For example, the registered performance between two LEs on the same row can be calculated by adding the following parameters:

■ LE register clock-to-output delay (t_{CO})
■ Interconnect delay ($t_{SAMEROW}$)
■ LE look-up table delay (t_{LUT})
■ LE register setup time (t_{SU})

The routing delay depends on the placement of the source and destination LEs. A more complex registered path may involve multiple combinatorial LEs between the source and destination LEs.

Symbol	Parameter	Conditions
*t*_{EABAA}	EAB address access delay	
*t*_{EABRCCOMB}	EAB asynchronous read cycle time	
*t*_{EABRCREG}	EAB synchronous read cycle time	
*t*_{EABWP}	EAB write pulse width	
*t*_{EABWCCOMB}	EAB asynchronous write cycle time	
*t*_{EABWCREG}	EAB synchronous write cycle time	
*t*_{EABDD}	EAB data-in to data-out valid delay	
*t*_{EABDATACO}	EAB clock-to-output delay when using output registers	
*t*_{EABDATASU}	EAB data/address setup time before clock when using input register	
*t*_{EABDATAH}	EAB data/address hold time after clock when using input register	
*t*_{EABWESU}	EAB WE setup time before clock when using input register	
*t*_{EABWEH}	EAB WE hold time after clock when using input register	
*t*_{EABWDSU}	EAB data setup time before falling edge of write pulse when not using input registers	
*t*_{EABWDH}	EAB data hold time after falling edge of write pulse when not using input registers	
*t*_{EABWASU}	EAB address setup time before rising edge of write pulse when not using input registers	
*t*_{EABWAH}	EAB address hold time after falling edge of write pulse when not using input registers	
*t*_{EABWO}	EAB write enable to data output valid delay	

Table 35. EAB Timing Macroparameters *Notes (1), (6)*

Tables 71 through 77 show EPF10K50V device internal and external timing parameters.

Table 71. EPF10K50V Device LE Timing Microparameters *Note (1)*

Symbol	-1 Speed Grade		-2 Speed Grade		-3 Speed Grade		-4 Speed Grade		Unit
	Min	Max	Min	Max	Min	Max	Min	Max	
t_{LUT}		0.9		1.0		1.3		1.6	ns
t_{CLUT}		0.1		0.5		0.6		0.6	ns
t_{RLUT}		0.5		0.8		0.9		1.0	ns
t_{PACKED}		0.4		0.4		0.5		0.7	ns
t_{EN}		0.7		0.9		1.1		1.4	ns
t_{CICO}		0.2		0.2		0.2		0.3	ns
t_{CGEN}		0.8		0.7		0.8		1.2	ns
t_{CGENR}		0.4		0.3		0.3		0.4	ns
t_{CASC}		0.7		0.7		0.8		0.9	ns
t_C		0.3		1.0		1.3		1.5	ns
t_{CO}		0.5		0.7		0.9		1.0	ns
t_{COMB}		0.4		0.4		0.5		0.6	ns
t_{SU}	0.8		1.6		2.2		2.5		ns
t_H	0.5		0.8		1.0		1.4		ns
t_{PRE}		0.8		0.4		0.5		0.5	ns
t_{CLR}		0.8		0.4		0.5		0.5	ns
t_{CH}	2.0		4.0		4.0		4.0		ns
t_{CL}	2.0		4.0		4.0		4.0		ns

Table 73. EPF10K50V Device EAB Internal Microparameters Note (1)

Symbol	-1 Speed Grade		-2 Speed Grade		-3 Speed Grade		-4 Speed Grade		Unit
	Min	Max	Min	Max	Min	Max	Min	Max	
$t_{EABDATA1}$		1.7		2.8		3.4		4.6	ns
$t_{EABDATA2}$		4.9		3.9		4.8		5.9	ns
t_{EABWE1}		0.0		2.5		3.0		3.7	ns
t_{EABWE2}		4.0		4.1		5.0		6.2	ns
t_{EABCLK}		0.4		0.8		1.0		1.2	ns
t_{EABCO}		0.1		0.2		0.3		0.4	ns
$t_{EABBYPASS}$		0.9		1.1		1.3		1.6	ns
t_{EABSU}	0.8		1.5		1.8		2.2		ns
t_{EABH}	0.8		1.6		2.0		2.5		ns
t_{AA}		5.5		8.2		10.0		12.4	ns
t_{WP}	6.0		4.9		6.0		7.4		ns
t_{WDSU}	0.1		0.8		1.0		1.2		ns
t_{WDH}	0.1		0.2		0.3		0.4		ns
t_{WASU}	0.1		0.4		0.5		0.6		ns
t_{WAH}	0.1		0.8		1.0		1.2		ns
t_{WO}		2.8		4.3		5.3		6.5	ns
t_{DD}		2.8		4.3		5.3		6.5	ns
t_{EABOUT}		0.5		0.4		0.5		0.6	ns
t_{EABCH}	2.0		4.0		4.0		4.0		ns
t_{EABCL}	6.0		4.9		6.0		7.4		ns

Table 81. EPF10K130V Device EAB Internal Timing Macroparameters *Note (1)*

Symbol	-2 Speed Grade		-3 Speed Grade		-4 Speed Grade		Unit
	Min	Max	Min	Max	Min	Max	
t_{EABAA}		11.2		14.2		14.2	ns
$t_{EABRCCOMB}$	11.1		14.2		14.2		ns
$t_{EABRCREG}$	8.5		10.8		10.8		ns
t_{EABWP}	3.7		4.7		4.7		ns
$t_{EABWCCOMB}$	7.6		9.7		9.7		ns
$t_{EABWCREG}$	14.0		17.8		17.8		ns
t_{EABDD}		11.1		14.2		14.2	ns
$t_{EABDATACO}$		3.6		4.6		4.6	ns
$t_{EABDATASU}$	4.4		5.6		5.6		ns
$t_{EABDATAH}$	0.0		0.0		0.0		ns
$t_{EABWESU}$	4.4		5.6		5.6		ns
t_{EABWEH}	0.0		0.0		0.0		ns
$t_{EABWDSU}$	4.6		5.9		5.9		ns
t_{EABWDH}	0.0		0.0		0.0		ns
$t_{EABWASU}$	3.9		5.0		5.0		ns
t_{EABWAH}	0.0		0.0		0.0		ns
t_{EABWO}		11.1		14.2		14.2	ns

Table 87. EPF10K10A Device EAB Internal Microparameters *Note (1)*

Symbol	-1 Speed Grade		-2 Speed Grade		-3 Speed Grade		Unit
	Min	Max	Min	Max	Min	Max	
$t_{EABDATA1}$		3.3		3.9		5.2	ns
$t_{EABDATA2}$		1.0		1.3		1.7	ns
t_{EABWE1}		2.6		3.1		4.1	ns
t_{EABWE2}		2.7		3.2		4.3	ns
t_{EABCLK}		0.0		0.0		0.0	ns
t_{EABCO}		1.2		1.4		1.8	ns
$t_{EABBYPASS}$		0.1		0.2		0.2	ns
t_{EABSU}	1.4		1.7		2.2		ns
t_{EABH}	0.1		0.1		0.1		ns
t_{AA}		4.5		5.4		7.3	ns
t_{WP}	2.0		2.4		3.2		ns
t_{WDSU}	0.7		0.8		1.1		ns
t_{WDH}	0.5		0.6		0.7		ns
t_{WASU}	0.6		0.7		0.9		ns
t_{WAH}	0.9		1.1		1.5		ns
t_{WO}		3.3		3.9		5.2	ns
t_{DD}		3.3		3.9		5.2	ns
t_{EABOUT}		0.1		0.1		0.2	ns
t_{EABCH}	3.0		3.5		4.0		ns
t_{EABCL}	3.03		3.5		4.0		ns

Table 95. EPF10K30A Device EAB Internal Timing Macroparameters *Note (1)*

Symbol	-1 Speed Grade		-2 Speed Grade		-3 Speed Grade		Unit
	Min	Max	Min	Max	Min	Max	
t_{EABAA}		9.7		11.6		16.2	ns
$t_{EABRCCOMB}$	9.7		11.6		16.2		ns
$t_{EABRCREG}$	5.9		7.1		9.7		ns
t_{EABWP}	3.8		4.5		5.9		ns
$t_{EABWCCOMB}$	4.0		4.7		6.3		ns
$t_{EABWCREG}$	9.8		11.6		16.6		ns
t_{EABDD}		9.2		11.0		16.1	ns
$t_{EABDATACO}$		1.7		2.1		3.4	ns
$t_{EABDATASU}$	2.3		2.7		3.5		ns
$t_{EABDATAH}$	0.0		0.0		0.0		ns
$t_{EABWESU}$	3.3		3.9		4.9		ns
t_{EABWEH}	0.0		0.0		0.0		ns
$t_{EABWDSU}$	3.2		3.8		5.0		ns
t_{EABWDH}	0.0		0.0		0.0		ns
$t_{EABWASU}$	3.7		4.4		5.1		ns
t_{EABWAH}	0.0		0.0		0.0		ns
t_{EABWO}		6.1		7.3		11.3	ns

Table 107. EPF10K250A Device IOE Timing Microparameters   Note (1)

Symbol	-1 Speed Grade		-2 Speed Grade		-3 Speed Grade		Unit
	Min	Max	Min	Max	Min	Max	
t_{IOD}		1.2		1.3		1.6	ns
t_{IOC}		0.4		0.4		0.5	ns
t_{IOCO}		0.8		0.9		1.1	ns
t_{IOCOMB}		0.7		0.7		0.8	ns
t_{IOSU}	2.7		3.1		3.6		ns
t_{IOH}	0.2		0.3		0.3		ns
t_{IOCLR}		1.2		1.3		1.6	ns
t_{OD1}		3.2		3.6		4.2	ns
t_{OD2}		5.9		6.7		7.8	ns
t_{OD3}		8.7		9.8		11.5	ns
t_{XZ}		3.8		4.3		5.0	ns
t_{ZX1}		3.8		4.3		5.0	ns
t_{ZX2}		6.5		7.4		8.6	ns
t_{ZX3}		9.3		10.5		12.3	ns
t_{INREG}		8.2		9.3		10.9	ns
t_{IOFD}		9.0		10.2		12.0	ns
t_{INCOMB}		9.0		10.2		12.0	ns

Table 108. EPF10K250A Device EAB Internal Microparameters *Note (1)*

Symbol	-1 Speed Grade		-2 Speed Grade		-3 Speed Grade		Unit
	Min	Max	Min	Max	Min	Max	
$t_{EABDATA1}$		1.3		1.5		1.7	ns
$t_{EABDATA2}$		1.3		1.5		1.7	ns
t_{EABWE1}		0.9		1.1		1.3	ns
t_{EABWE2}		5.0		5.7		6.7	ns
t_{EABCLK}		0.6		0.7		0.8	ns
t_{EABCO}		0.0		0.0		0.0	ns
$t_{EABBYPASS}$		0.1		0.1		0.2	ns
t_{EABSU}	3.8		4.3		5.0		ns
t_{EABH}	0.7		0.8		0.9		ns
t_{AA}		4.5		5.0		5.9	ns
t_{WP}	5.6		6.4		7.5		ns
t_{WDSU}	1.3		1.4		1.7		ns
t_{WDH}	0.1		0.1		0.2		ns
t_{WASU}	0.1		0.1		0.2		ns
t_{WAH}	0.1		0.1		0.2		ns
t_{WO}		4.1		4.6		5.5	ns
t_{DD}		4.1		4.6		5.5	ns
t_{EABOUT}		0.1		0.1		0.2	ns
t_{EABCH}	2.5		3.0		3.5		ns
t_{EABCL}	5.6		6.4		7.5		ns

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Table 109. EPF10K250A Device EAB Internal Timing Macroparameters *Note (1)*

Symbol	-1 Speed Grade		-2 Speed Grade		-3 Speed Grade		Unit
	Min	Max	Min	Max	Min	Max	
t_{EABAA}		6.1		6.8		8.2	ns
$t_{EABRCCOMB}$	6.1		6.8		8.2		ns
$t_{EABRCREG}$	4.6		5.1		6.1		ns
t_{EABWP}	5.6		6.4		7.5		ns
$t_{EABWCCOMB}$	5.8		6.6		7.9		ns
$t_{EABWCREG}$	15.8		17.8		21.0		ns
t_{EABDD}		5.7		6.4		7.8	ns
$t_{EABDATACO}$		0.7		0.8		1.0	ns
$t_{EABDATASU}$	4.5		5.1		5.9		ns
$t_{EABDATAH}$	0.0		0.0		0.0		ns
$t_{EABWESU}$	8.2		9.3		10.9		ns
t_{EABWEH}	0.0		0.0		0.0		ns
$t_{EABWDSU}$	1.7		1.8		2.1		ns
t_{EABWDH}	0.0		0.0		0.0		ns
$t_{EABWASU}$	0.9		0.9		1.0		ns
t_{EABWAH}	0.0		0.0		0.0		ns
t_{EABWO}		5.3		6.0		7.4	ns

Table 113. ClockLock & ClockBoost Parameters   (Part 2 of 2)

Symbol	Parameter	Min	Typ	Max	Unit
$f_{CLKDEV1}$	Input deviation from user specification in MAX+PLUS II (ClockBoost clock multiplication factor equals 1) (1)			±1	MHz
$f_{CLKDEV2}$	Input deviation from user specification in MAX+PLUS II (ClockBoost clock multiplication factor equals 2) (1)			±0.5	MHz
$t_{INCLKSTB}$	Input clock stability (measured between adjacent clocks)			100	ps
t_{LOCK}	Time required for ClockLock or ClockBoost to acquire lock (2)			10	µs
t_{JITTER}	Jitter on ClockLock or ClockBoost-generated clock (3)			1	ns
$t_{OUTDUTY}$	Duty cycle for ClockLock or ClockBoost-generated clock	40	50	60	%

Notes:
(1) To implement the ClockLock and ClockBoost circuitry with the MAX+PLUS II software, designers must specify the input frequency. The MAX+PLUS II software tunes the PLL in the ClockLock and ClockBoost circuitry to this frequency. The f_{CLKDEV} parameter specifies how much the incoming clock can differ from the specified frequency during device operation. Simulation does not reflect this parameter.
(2) During device configuration, the ClockLock and ClockBoost circuitry is configured before the rest of the device. If the incoming clock is supplied during configuration, the ClockLock and ClockBoost circuitry locks during configuration, because the t_{LOCK} value is less than the time required for configuration.
(3) The t_{JITTER} specification is measured under long-term observation.

Power Consumption

The supply power (P) for FLEX 10K devices can be calculated with the following equation:

$$P = P_{INT} + P_{IO} = (I_{CCSTANDBY} + I_{CCACTIVE}) \times V_{CC} + P_{IO}$$

Typical $I_{CCSTANDBY}$ values are shown as I_{CC0} in the FLEX 10K device DC operating conditions tables on pages 46, 49, and 52 of this data sheet. The $I_{CCACTIVE}$ value depends on the switching frequency and the application logic. This value is calculated based on the amount of current that each LE typically consumes. The P_{IO} value, which depends on the device output load characteristics and switching frequency, can be calculated using the guidelines given in *Application Note 74 (Evaluating Power for Altera Devices)*.

☞ Compared to the rest of the device, the embedded array consumes a negligible amount of power. Therefore, the embedded array can be ignored when calculating supply current.

The $I_{CCACTIVE}$ value is calculated with the following equation:

$$I_{CCACTIVE} = K \times f_{MAX} \times N \times tog_{LC} \times \frac{\mu A}{MHz \times LE}$$

The parameters in this equation are shown below:

Notes: