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Understanding Embedded - FPGAs (Field Programmable Gate Array)

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

Applications of Embedded - FPGAs

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

Details	
Product Status	Active
Number of LABs/CLBs	-
Number of Logic Elements/Cells	-
Total RAM Bits	516096
Number of I/O	620
Number of Gates	3000000
Voltage - Supply	1.425V ~ 1.575V
Mounting Type	Surface Mount
Operating Temperature	-55°C ~ 125°C (TJ)
Package / Case	896-BGA
Supplier Device Package	896-FBGA (31x31)
Purchase URL	https://www.e-xfl.com/product-detail/microchip-technology/a3pe3000l-1fgg896m

Reduced Cost of Ownership

Advantages to the designer extend beyond low unit cost, performance, and ease of use. Unlike SRAM-based FPGAs, flash-based military ProASIC3/EL devices allow all functionality to be live at power-up; no external boot PROM is required. On-board security mechanisms prevent access to all the programming information and enable secure remote updates of the FPGA logic. Designers can perform secure remote in-system reprogramming to support future design iterations and field upgrades with confidence that valuable intellectual property cannot be compromised or copied. Secure ISP can be performed using the industry-standard AES algorithm. The military ProASIC3/EL family device architecture mitigates the need for ASIC migration at higher volumes. This makes the military ProASIC3/EL family a cost-effective ASIC replacement.

Firm-Error Immunity

Firm errors occur most commonly when high-energy neutrons, generated in the upper atmosphere, strike a configuration cell of an SRAM FPGA. The energy of the collision can change the state of the configuration cell and thus change the logic, routing, or I/O behavior in an unpredictable way. These errors are impossible to prevent in SRAM FPGAs. The consequence of this type of error can be a complete system failure. Firm errors do not exist in the configuration memory of military ProASIC3/EL flash-based FPGAs. Once it is programmed, the flash cell configuration element of military ProASIC3/EL FPGAs cannot be altered by high-energy neutrons and is therefore immune to them. Recoverable (or soft) errors occur in the user data SRAM of all FPGA devices. These can easily be mitigated by using error detection and correction (EDAC) circuitry built into the FPGA fabric.

Advanced Flash Technology

The military ProASIC3/EL family offers many benefits, including nonvolatility and reprogrammability, through an advanced flash-based, 130-nm LVCMOS process with 7 layers of metal. Standard CMOS design techniques are used to implement logic and control functions. The combination of fine granularity, enhanced flexible routing resources, and abundant flash switches allows for very high logic utilization without compromising device routability or performance. Logic functions within the device are interconnected through a four-level routing hierarchy.

Advanced Architecture

The proprietary military ProASIC3/EL architecture provides granularity comparable to standard-cell ASICs. The military ProASIC3/EL device consists of five distinct and programmable architectural features (Figure 1-1 on page 1-4 and Figure 1-2 on page 1-4):

- FPGA VersaTiles
- Dedicated FlashROM
- Dedicated SRAM/FIFO memory
- Extensive CCCs and PLLs
- I/O structure

The FPGA core consists of a sea of VersaTiles. Each VersaTile can be configured as a three-input logic function, a D-flip-flop (with or without enable), or a latch by programming the appropriate flash switch interconnections. The versatility of the military ProASIC3/EL core tile, as either a three-input lookup table (LUT) equivalent or a D-flip-flop/latch with enable, allows for efficient use of the FPGA fabric. The VersaTile capability is unique to the ProASIC family of third-generation-architecture flash FPGAs. VersaTiles are connected with any of the four levels of routing hierarchy. Flash switches are distributed throughout the device to provide nonvolatile, reconfigurable interconnect programming. Maximum core utilization is possible for virtually any design.

User Nonvolatile FlashROM

Military ProASIC3/EL devices have 1 kbit of on-chip, user-accessible, nonvolatile FlashROM. The FlashROM can be used in diverse system applications:

- Internet protocol addressing (wireless or fixed)
- System calibration settings
- Device serialization and/or inventory control
- Subscription-based business models (for example, set-top boxes)
- Secure key storage for secure communications algorithms
- Asset management/tracking
- Date stamping
- Version management

FlashROM is written using the standard military ProASIC3/EL IEEE 1532 JTAG programming interface. The core can be individually programmed (erased and written), and on-chip AES decryption can be used selectively to securely load data over public networks, as in security keys stored in the FlashROM for a user design.

FlashROM can be programmed via the JTAG programming interface, and its contents can be read back either through the JTAG programming interface or via direct FPGA core addressing. Note that the FlashROM can only be programmed from the JTAG interface and cannot be programmed from the internal logic array.

FlashROM is programmed as 8 banks of 128 bits; however, reading is performed on a byte-by-byte basis using a synchronous interface. A 7-bit address from the FPGA core defines which of the 8 banks and which of the 16 bytes within that bank are being read. The three most significant bits (MSBs) of the FlashROM address determine the bank, and the four least significant bits (LSBs) of the FlashROM address define the byte.

Microsemi military ProASIC3/EL development software solutions, Libero SoC has extensive support for the FlashROM. One such feature is auto-generation of sequential programming files for applications requiring a unique serial number in each part. Another feature allows the inclusion of static data for system version control. Data for the FlashROM can be generated quickly and easily using the Libero SoC software tools. Comprehensive programming file support is also included to allow for easy programming of large numbers of parts with differing FlashROM contents.

SRAM and FIFO

Military ProASIC3/EL devices have embedded SRAM blocks along their north and south sides. Each variable-aspect-ratio SRAM block is 4,608 bits in size. Available memory configurations are 256×18, 512×9, 1k×4, 2k×2, and 4k×1 bits. The individual blocks have independent read and write ports that can be configured with different bit widths on each port. For example, data can be sent through a 4-bit port and read as a single bitstream. The embedded SRAM blocks can be initialized via the device JTAG port (ROM emulation mode) using the UJTAG macro.

In addition, every SRAM block has an embedded FIFO control unit. The control unit allows the SRAM block to be configured as a synchronous FIFO without using additional core VersaTiles. The FIFO width and depth are programmable. The FIFO also features programmable Almost Empty (AEMPTY) and Almost Full (AFULL) flags in addition to the normal Empty and Full flags. The embedded FIFO control unit contains the counters necessary for generation of the read and write address pointers. The embedded SRAM/FIFO blocks can be cascaded to create larger configurations.

PLL and CCC

Military ProASIC3 devices provide designers with flexible clock conditioning circuit (CCC) capabilities. Each member of the military ProASIC3 family contains six CCCs, located at the four corners and the centers of the east and west sides. One CCC (center west side) has a PLL. All six CCC blocks are usable; the four corner CCCs and the east CCC allow simple clock delay operations as well as clock spine access.

Military ProASIC3EL devices also contain six CCCs; however, all six are equipped with a PLL.

The inputs of the six CCC blocks are accessible from the FPGA core or from one of several inputs located near the CCC that have dedicated connections to the CCC block.

EQ 2

Table 2-5 • Package Thermal Resistivities

Package Type	Device	Pin Count	θ_{jc}	θ_{ja}			Units
				Still Air	200 ft./min.	500 ft./min.	
Very Thin Quad Flat Pack (VQ100)	A3P250	100	10.0	35.3	29.4	27.1	C/W
Plastic Quad Flat Pack (PQ208)*	A3P1000	208	3.8	16.2	13.3	11.9	C/W
Fine Pitch Ball Grid Array (FBGA)	A3P1000	144	6.3	31.6	26.2	24.2	C/W
	A3P1000	256	6.6	28.1	24.4	22.7	C/W
	A3P1000	484	8.0	23.3	19.0	16.7	C/W
	A3PE600L	484	9.5	27.5	21.9	20.2	C/W
	A3PE3000L	484	4.7	20.6	15.7	14.0	C/W
	A3PE3000L	896	2.4	13.6	10.4	9.4	C/W

* *Embedded heatspreader*

Temperature and Voltage Derating Factors

Table 2-6 • Temperature and Voltage Derating Factors for Timing Delays (normalized to T_J = 125°C, VCC = 1.14 V) Applicable to A3PE600L and A3PE3000L Only

	Junction Temperature						
Array Voltage VCC (V)	**–55°C**	**–40°C**	**0°C**	**25°C**	**70°C**	**85°C**	**125°C**
1.14	0.85	0.86	0.89	0.92	0.96	0.97	1.00
1.2	0.82	0.83	0.86	0.88	0.92	0.93	0.96
1.26	0.79	0.80	0.83	0.85	0.89	0.90	0.93
1.30	0.77	0.78	0.81	0.83	0.86	0.88	0.90
1.35	0.74	0.75	0.78	0.80	0.84	0.85	0.88
1.40	0.72	0.73	0.75	0.77	0.81	0.82	0.85
1.425	0.71	0.71	0.74	0.76	0.79	0.80	0.83
1.5	0.67	0.68	0.70	0.72	0.75	0.76	0.79
1.575	0.65	0.66	0.68	0.70	0.73	0.74	0.76

Table 2-7 • Temperature and Voltage Derating Factors for Timing Delays (normalized to T_J = 125°C, VCC = 1.425 V) Applicable to A3P250 and A3P1000 Devices Only

	Junction Temperature						
Array Voltage VCC (V)	**–55°C**	**–40°C**	**0°C**	**25°C**	**70°C**	**85°C**	**125°C**
1.425	0.80	0.82	0.87	0.89	0.94	0.96	1.00
1.5	0.76	0.78	0.82	0.84	0.89	0.91	0.95
1.575	0.73	0.75	0.79	0.82	0.86	0.87	0.91

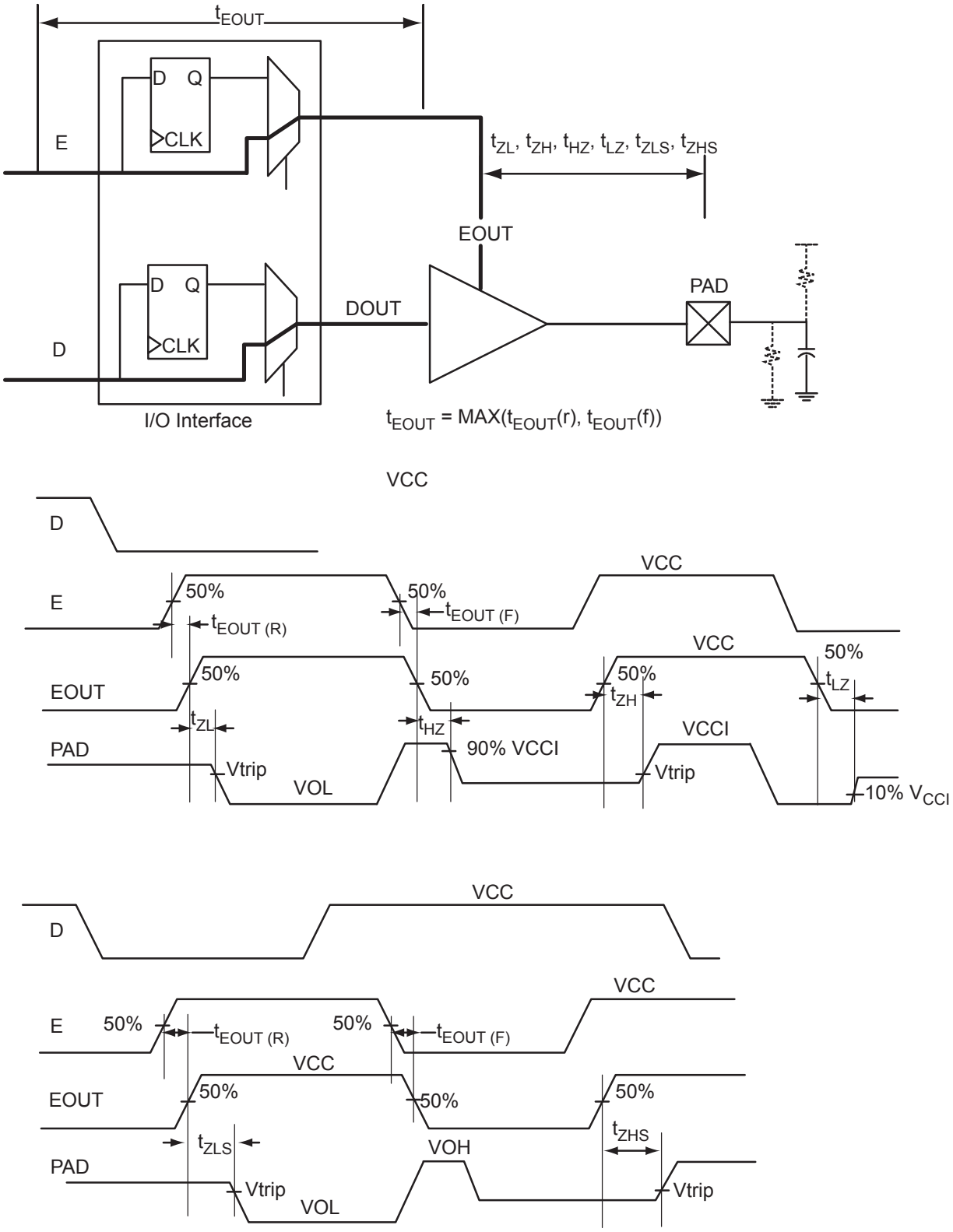


Figure 2-6 • **Tristate Output Buffer Timing Model and Delays (example)**

Table 2-37 • I/O Output Buffer Maximum Resistances [1]
Applicable to Advanced I/O Banks for A3P250 and A3P1000 Only

Standard	Drive Strength	$R_{PULL\text{-}DOWN}$ (Ω) [2]	$R_{PULL\text{-}UP}$ (Ω) [3]
3.3 V LVTTL / 3.3 V LVCMOS	2 mA	100	300
	4 mA	100	300
	6 mA	50	150
	8 mA	50	150
	12 mA	25	75
	16 mA	17	50
	24 mA	11	33
3.3 V LVCMOS Wide Range	100 µA	Same as regular 3.3 V LVCMOS	
2.5 V LVCMOS	2 mA	100	300
	4 mA	100	300
	6 mA	50	150
	8 mA	50	150
	12 mA	25	75
	16 mA	17	50
	24 mA	11	33
1.8 V LVCMOS	2 mA	100	200
	4 mA	100	200
	6 mA	50	100
	8 mA	50	100
	12 mA	25	50
	16 mA	20	40
1.5 V LVCMOS	2 mA	200	224
	4 mA	100	112
	6 mA	67	75
	8 mA	33	37
	12 mA	33	37
3.3 V PCI/PCI-X	Per PCI/PCI-X specification	25	75

Notes:

1. *These maximum values are provided for informational reasons only. Minimum output buffer resistance values depend on V_{CCI}, drive strength selection, temperature, and process. For board design considerations and detailed output buffer resistances, use the corresponding IBIS models located at http://www.microsemi.com/products/fpga-soc/design-resources/ibis-models.*
2. $R_{(PULL\text{-}DOWN\text{-}MAX)} = (VOLspec) / I_{OLspec}$
3. $R_{(PULL\text{-}UP\text{-}MAX)} = (VCCImax - VOHspec) / I_{OHspec}$

Table 2-40 • I/O Short Currents IOSH/IOSL
Applicable to Pro I/Os for A3PE600L and A3PE3000L Only

	Drive Strength	I_{OSL} (mA)[1]	I_{OSH} (mA)[1]
3.3 V LVTTL / 3.3 V LVCMOS	4 mA	25	27
	8 mA	51	54
	12 mA	103	109
	16 mA	132	127
	24 mA	268	181
3.3 V LVCMOS Wide Range	100 µA	Same specification as regular LVCMOS 3.3 V	
2.5 V LVCMOS	4 mA	16	18
	8 mA	32	37
	12 mA	65	74
	16 mA	83	87
	24 mA	169	124
1.8 V LVCMOS	2 mA	9	11
	4 mA	17	22
	6 mA	35	44
	8 mA	45	51
	12 mA	91	74
	16 mA	91	74
1.5 V LVCMOS	2 mA	13	16
	4 mA	25	33
	6 mA	32	39
	8 mA	66	55
	12 mA	66	55
1.2 V LVCMOS	2 mA	TBD	TBD
1.2 V LVCMOS Wide Range	100 µA	TBD	TBD
3.3 V PCI/PCIX	Per PCI/PCI-X specification	Per PCI Curves	
3.3 V GTL	20 mA[2]	268	181
2.5 V GTL	20 mA[2]	169	124
3.3 V GTL+	35 mA	268	181
2.5 V GTL+	33 mA	169	124
HSTL (I)	8 mA	32	39
HSTL (II)	15 mA[2]	66	55
SSTL2 (I)	15 mA	83	87
SSTL2 (II)	18 mA	169	124
SSTL3 (I)	14 mA	51	54
SSTL3 (II)	21 mA	103	109

Notes:

1. *T_J = 100°C*
2. *Output drive strength is below JEDEC specification.*

Table 2-60 • Minimum and Maximum DC Input and Output Levels Applicable to Standard Plus I/O Banks

3.3 V LVCMOS Wide Range	Equiv. Software Default Drive Strength Option[1]	VIL		VIH		VOL	VOH	IOL	IOH	IOSL	IOSH	IIL[2]	IIH[3]
Drive Strength		Min. V	Max. V	Min. V	Max. V	Max. V	Min. V	µA	µA	Max. mA[4]	Max. mA[4]	µA[5]	µA[5]
100 µA	2 mA	–0.3	0.8	2	3.6	0.2	VCCI – 0.2	100	100	25	27	15	15
100 µA	4 mA	–0.3	0.8	2	3.6	0.2	VCCI – 0.2	100	100	25	27	15	15
100 µA	6 mA	–0.3	0.8	2	3.6	0.2	VCCI – 0.2	100	100	51	54	15	15
100 µA	8 mA	–0.3	0.8	2	3.6	0.2	VCCI – 0.2	100	100	51	54	15	15
100 µA	12 mA	–0.3	0.8	2	3.6	0.2	VCCI – 0.2	100	100	103	109	15	15
100 µA	16 mA	–0.3	0.8	2	3.6	0.2	VCCI – 0.2	100	100	132	127	15	15

Notes:

1. *Note that 3.3 V LVCMOS wide range is applicable to 100 µA drive strength only. The configuration will not operate at the equivalent software default drive strength. These values are for normal ranges only.*
2. *I_{IL} is the input leakage current per I/O pin over recommended operation conditions where –0.3 V < VIN < VIL.*
3. *I_{IH} is the input leakage current per I/O pin over recommended operating conditions VIH < VIN < VCCI. Input current is larger when operating outside recommended ranges*
4. *Currents are measured at 125°C junction temperature.*
5. *All LVMCOS 3.3 V software macros support LVCMOS 3.3 V wide range as specified in the JESD8-A specification.*
6. *Software default selection highlighted in gray.*

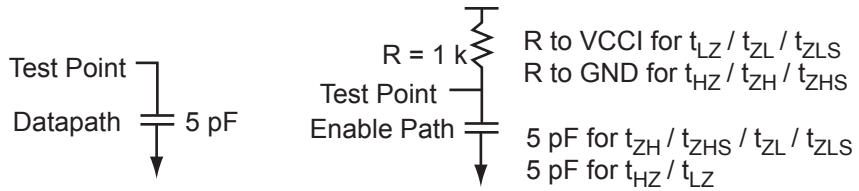


Figure 2-8 • AC Loading

Table 2-61 • AC Waveforms, Measuring Points, and Capacitive Loads

Input Low (V)	Input High (V)	Measuring Point* (V)	VREF (Typ) (V)	C_{LOAD} (pF)
0	3.3	1.4	–	5

*Note: *Measuring point = V_{trip}. See Table 2-29 on page 2-25 for a complete table of trip points.*

Table 2-72 • Minimum and Maximum DC Input and Output Levels Applicable to Standard Plus I/O Banks for A3P250 and A3P1000 Only

2.5 V LVCMOS	VIL		VIH		VOL	VOH	I_{OL}	I_{OH}	I_{OSL}	I_{OSH}	I_{IL} [1]	I_{IH} [2]
Drive Strength	Min. V	Max. V	Min. V	Max. V	Max. V	Min. V	mA	mA	Max. mA [3]	Max. mA [3]	µA [4]	µA [5]
2 mA	–0.3	0.7	1.7	2.7	0.7	1.7	2	2	16	18	15	15
4 mA	–0.3	0.7	1.7	2.7	0.7	1.7	4	4	16	18	15	15
6 mA	–0.3	0.7	1.7	2.7	0.7	1.7	6	6	32	37	15	15
8 mA	–0.3	0.7	1.7	2.7	0.7	1.7	8	8	32	37	15	15
12 mA	–0.3	0.7	1.7	2.7	0.7	1.7	12	12	65	74	15	15

Notes:

1. *I_{IL} is the input leakage current per I/O pin over recommended operation conditions where –0.3 V < VIN < VIL.*
2. *I_{IH} is the input leakage current per I/O pin over recommended operating conditions VIH < VIN < VCCI. Input current is larger when operating outside recommended ranges*
3. *Currents are measured at 100°C junction temperature and maximum voltage.*
4. *Currents are measured at 125°C junction temperature.*
5. *Software default selection highlighted in gray.*

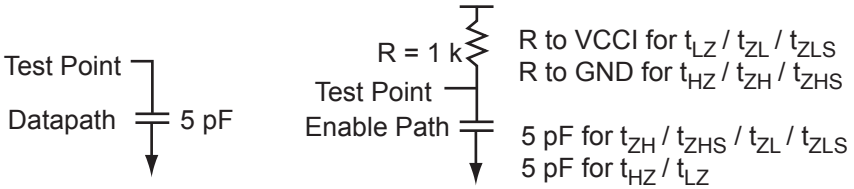


Figure 2-9 • AC Loading

Table 2-73 • AC Waveforms, Measuring Points, and Capacitive Loads

Input Low (V)	Input High (V)	Measuring Point* (V)	VREF (Typ) (V)	C_{LOAD} (pF)
0	2.5	1.2	–	5

*Note: *Measuring point = V_{trip}. See Table 2-29 on page 2-25 for a complete table of trip points.*

1.5 V DC Core Voltage

Table 2-88 • 1.8 V LVCMOS Low Slew
Military-Case Conditions: T_J = 125°C, VCC = 1.425 V, Worst-Case VCCI = 1.7 V
Applicable to Pro I/Os for A3PE600L and A3PE3000L Only

Drive Strength	Speed Grade	t_{DOUT}	t_{DP}	t_{DIN}	t_{PY}	t_{PYS}	t_{EOUT}	t_{ZL}	t_{ZH}	t_{LZ}	t_{HZ}	t_{ZLS}	t_{ZHS}	Units
2 mA	Std.	0.61	9.02	0.04	1.69	2.52	0.40	9.17	7.57	2.61	1.01	10.63	9.04	ns
	–1	0.52	7.68	0.03	1.44	2.14	0.34	7.80	6.44	2.22	0.86	9.04	7.69	ns
4 mA	Std.	0.61	7.41	0.04	1.69	2.52	0.40	7.52	6.36	3.07	2.56	8.99	7.83	ns
	–1	0.52	6.30	0.03	1.44	2.14	0.34	6.40	5.41	2.62	2.18	7.64	6.66	ns
6 mA	Std.	0.61	6.26	0.04	1.69	2.52	0.40	6.35	5.53	3.38	3.14	7.82	7.00	ns
	–1	0.52	5.33	0.03	1.44	2.14	0.34	5.40	4.71	2.88	2.67	6.65	5.95	ns
8 mA	Std.	0.61	5.88	0.04	1.69	2.52	0.40	5.96	5.37	3.45	3.30	7.42	6.83	ns
	–1	0.52	5.00	0.03	1.44	2.14	0.34	5.07	4.57	2.94	2.81	6.32	5.81	ns
12 mA	Std.	0.61	5.76	0.04	1.69	2.52	0.40	5.85	5.38	3.55	3.88	7.31	6.84	ns
	–1	0.52	4.90	0.03	1.44	2.14	0.34	4.97	4.57	3.02	3.30	6.22	5.82	ns
16 mA	Std.	0.61	5.76	0.04	1.69	2.52	0.40	5.85	5.38	3.55	3.88	7.31	6.84	ns
	–1	0.52	4.90	0.03	1.44	2.14	0.34	4.97	4.57	3.02	3.30	6.22	5.82	ns

Note: For specific junction temperature and voltage supply levels, refer to Table 2-6 on page 2-6 for derating values.

Table 2-89 • 1.8 V LVCMOS High Slew
Military-Case Conditions: T_J = 125°C, VCC = 1.425 V, Worst-Case VCCI = 1.7 V
Applicable to Pro I/Os for A3PE600L and A3PE3000L Only

Drive Strength	Speed Grade	t_{DOUT}	t_{DP}	t_{DIN}	t_{PY}	t_{PYS}	t_{EOUT}	t_{ZL}	t_{ZH}	t_{LZ}	t_{HZ}	t_{ZLS}	t_{ZHS}	Units
2 mA	Std.	0.61	4.01	0.04	1.69	2.52	0.40	4.06	3.94	2.60	1.03	5.52	5.40	ns
	–1	0.52	3.41	0.03	1.44	2.14	0.34	3.45	3.35	2.21	0.88	4.70	4.60	ns
4 mA	Std.	0.61	3.22	0.04	1.69	2.52	0.40	3.26	2.89	3.07	2.65	4.72	4.36	ns
	–1	0.52	2.74	0.03	1.44	2.14	0.34	2.77	2.46	2.61	2.26	4.02	3.71	ns
6 mA	Std.	0.61	2.74	0.04	1.69	2.52	0.40	2.77	2.38	3.38	3.23	4.23	3.84	ns
	–1	0.52	2.33	0.03	1.44	2.14	0.34	2.36	2.02	2.88	2.75	3.60	3.27	ns
8 mA	Std.	0.61	2.65	0.04	1.69	2.52	0.40	2.68	2.28	3.45	3.40	4.14	3.75	ns
	–1	0.52	2.26	0.03	1.44	2.14	0.34	2.28	1.94	2.93	2.89	3.52	3.19	ns
12 mA	Std.	0.61	2.64	0.04	1.69	2.52	0.40	2.66	2.16	3.55	4.01	4.13	3.63	ns
	–1	0.52	2.24	0.03	1.44	2.14	0.34	2.26	1.84	3.02	3.41	3.51	3.08	ns
16 mA	Std.	0.61	2.64	0.04	1.69	2.52	0.40	2.66	2.16	3.55	4.01	4.13	3.63	ns
	–1	0.52	2.24	0.03	1.44	2.14	034	2.26	1.84	3.02	3.41	3.51	3.08	ns

Notes:

1. *Software default selection highlighted in gray.*
2. *For specific junction temperature and voltage supply levels, refer to Table 2-6 on page 2-6 for derating values.*

Table 2-102 • 1.5 V LVCMOS Low Slew
Military-Case Conditions: T_J = 125°C, Worst-Case VCC = 1.425 V, Worst-Case VCCI = 1.4 V
Applicable to Advanced I/O Banks

Drive Strength	Speed Grade	t_{DOUT}	t_{DP}	t_{DIN}	t_{PY}	t_{EOUT}	t_{ZL}	t_{ZH}	t_{LZ}	t_{HZ}	t_{ZLS}	t_{ZHS}	Units
2 mA	Std.	0.63	9.78	0.05	1.44	0.45	9.96	8.57	3.74	2.91	12.42	11.03	ns
	–1	0.54	8.32	0.04	1.23	0.39	8.47	7.29	3.18	2.47	10.56	9.38	ns
4 mA	Std.	0.63	8.44	0.05	1.44	0.45	8.60	7.59	4.12	3.60	11.06	10.05	ns
	–1	0.54	7.18	0.04	1.23	0.39	7.32	6.46	3.51	3.06	9.41	8.55	ns
6 mA	Std.	0.63	7.95	0.05	1.44	0.45	8.10	7.39	4.21	3.78	10.56	9.85	ns
	–1	0.54	6.77	0.04	1.23	0.39	6.89	6.29	3.58	3.21	8.98	8.38	ns
8 mA	Std.	0.63	7.84	0.05	1.44	0.45	7.98	7.47	4.35	4.45	10.44	9.92	ns
	–1	0.54	6.67	0.04	1.23	0.39	6.79	6.35	3.70	3.79	8.88	8.44	ns
12 mA	Std.	0.63	7.84	0.05	1.44	0.45	7.98	7.47	4.35	4.45	10.44	9.92	ns
	–1	0.54	6.67	0.04	1.23	0.39	6.79	6.35	3.70	3.79	8.88	8.44	ns

Note: For specific junction temperature and voltage supply levels, refer to Table 2-7 on page 2-6 for derating values.

Table 2-103 • 1.5 V LVCMOS High Slew
Military-Case Conditions: T_J = 125°C, Worst-Case VCC = 1.425 V, Worst-Case VCCI = 1.4 V
Applicable to Advanced I/O Banks

Drive Strength	Speed Grade	t_{DOUT}	t_{DP}	t_{DIN}	t_{PY}	t_{EOUT}	t_{ZL}	t_{ZH}	t_{LZ}	t_{HZ}	t_{ZLS}	t_{ZHS}	Units
2 mA	Std.	0.63	3.98	0.05	1.58	0.45	4.06	3.80	3.73	3.04	6.52	6.26	ns
	–1	0.54	3.39	0.04	1.35	0.39	3.45	3.23	3.17	2.59	5.54	5.32	ns
4 mA	Std.	0.63	3.47	0.05	1.58	0.45	3.53	3.15	4.11	3.74	5.99	5.61	ns
	–1	0.54	2.95	0.04	1.35	0.39	3.01	2.68	3.50	3.18	5.10	4.77	ns
6 mA	Std.	0.63	3.37	0.05	1.58	0.45	3.43	3.02	4.20	3.92	5.89	5.48	ns
	–1	0.54	2.87	0.04	1.35	0.39	2.92	2.57	3.57	3.33	5.01	4.66	ns
8 mA	Std.	0.63	3.35	0.05	1.58	0.45	3.41	2.88	4.34	4.62	5.87	5.34	ns
	–1	0.54	2.85	0.04	1.35	0.39	2.90	2.45	3.69	3.93	4.99	4.55	ns
12 mA	Std.	0.63	3.35	0.05	1.58	0.45	3.41	2.88	4.34	4.62	5.87	5.34	ns
	–1	0.54	2.85	0.04	1.35	0.39	2.90	2.45	3.69	3.93	4.99	4.55	ns

Notes:

1. *Software default selection highlighted in gray.*
2. *For specific junction temperature and voltage supply levels, refer to Table 2-7 on page 2-6 for derating values.*

Table 2-143 • HSTL Class II
Military-Case Conditions: T_J = 125°C, VCC = 1.425 V,
Worst-Case VCCI = 1.4 V, VREF = 0.75 V
Applicable to Pro I/Os for A3PE600L and A3PE3000L Only

Speed Grade	t_{DOUT}	t_{DP}	t_{DIN}	t_{PY}	t_{EOUT}	t_{ZL}	t_{ZH}	t_{LZ}	t_{HZ}	t_{ZLS}	t_{ZHS}	Units
Std.	0.61	2.86	0.04	2.52	0.40	2.89	2.57	–	–	4.36	4.04	ns
–1	0.52	2.44	0.03	2.14	0.34	2.46	2.19	–	–	3.71	3.43	ns

Note: For specific junction temperature and voltage supply levels, refer to Table 2-6 on page 2-6 for derating values.

SSTL2 Class I

Stub-Speed Terminated Logic for 2.5 V memory bus standard (JESD8-9). Military ProASIC3E devices support Class I. This provides a differential amplifier input buffer and a push-pull output buffer.

Table 2-144 • Minimum and Maximum DC Input and Output Levels

SSTL2 Class I	VIL		VIH		VOL	VOH	I_{OL}	I_{OH}	I_{OSL}	I_{OSH}	I_{IL} [1]	I_{IH} [2]
Drive Strength	Min. V	Max. V	Min. V	Max. V	Max. V	Min. V	mA	mA	Max. mA [3]	Max. mA [3]	µA [4]	µA [4]
15 mA	–0.3	VREF – 0.2	VREF + 0.2	3.6	0.54	VCCI – 0.62	15	15	83	87	15	15

Notes:

1. *I_{IL} is the input leakage current per I/O pin over recommended operating conditions where –0.3 V < VIN < VIL.*
2. *I_{IH} is the input leakage current per I/O pin over recommended operating conditions VIH < VIN < VCCI. Input current is larger when operating outside recommended ranges.*
3. *Currents are measured at 100°C junction temperature and maximum voltage.*
4. *Currents are measured at 125°C junction temperature.*

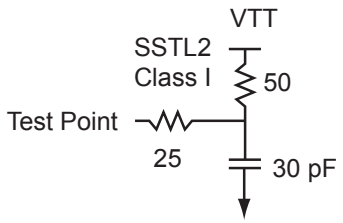


Figure 2-21 • AC Loading

Table 2-145 • AC Waveforms, Measuring Points, and Capacitive Loads

Input Low (V)	Input High (V)	Measuring Point* (V)	VREF (typ.) (V)	VTT (typ.) (V)	C_{LOAD} (pF)
VREF – 0.2	VREF + 0.2	1.25	1.25	1.25	30

*Note: *Measuring point = Vtrip. See Table 2-29 on page 2-25 for a complete table of trip points.*

Timing Characteristics

Table 2-146 • SSTL2 Class I
Military-Case Conditions: T_J = 125°C, Worst-Case VCC = 1.14 V,
Worst-Case VCCI = 2.3 V, VREF = 1.25 V
Applicable to Pro I/Os for A3PE600L and A3PE3000L Only

Speed Grade	t_{DOUT}	t_{DP}	t_{DIN}	t_{PY}	t_{EOUT}	t_{ZL}	t_{ZH}	t_{LZ}	t_{HZ}	t_{ZLS}	t_{ZHS}	Units
Std.	0.80	2.11	0.05	2.09	0.52	2.14	1.83	–	–	2.14	1.83	ns
–1	0.68	1.80	0.05	1.78	0.44	1.82	1.55	–	–	1.82	1.55	ns

Note: For specific junction temperature and voltage supply levels, refer to Table 2-6 on page 2-6 for derating values.

Table 2-151 • SSTL2 Class II
Military-Case Conditions: T_J = 125°C, VCC = 1.425 V,
Worst-Case VCCI = 2.3 V, VREF = 1.25 V
Applicable to Pro I/Os for A3PE600L and A3PE3000L Only

Speed Grade	t_{DOUT}	t_{DP}	t_{DIN}	t_{PY}	t_{EOUT}	t_{ZL}	t_{ZH}	t_{LZ}	t_{HZ}	t_{ZLS}	t_{ZHS}	Units
Std.	0.61	2.02	0.04	1.85	0.40	2.03	1.64	–	–	2.03	1.64	ns
–1	0.52	1.72	0.03	1.58	0.34	1.73	1.39	–	–	1.73	1.39	ns

Note: For specific junction temperature and voltage supply levels, refer to Table 2-6 on page 2-6 for derating values.

SSTL3 Class I

Stub-Speed Terminated Logic for 3.3 V memory bus standard (JESD8-8). Military ProASIC3E devices support Class I. This provides a differential amplifier input buffer and a push-pull output buffer.

Table 2-152 • Minimum and Maximum DC Input and Output Levels

SSTL3 Class I	VIL		V_{IH}		VOL	VOH	I_{OL}	I_{OH}	I_{OSL}	I_{OSH}	I_{IL} [1]	I_{IH} [2]
Drive Strength	Min. V	Max. V	Min. V	Max. V	Max. V	Min. V	mA	mA	Max. mA [3]	Max. mA [3]	µA [4]	µA [4]
14 mA	–0.3	VREF – 0.2	VREF + 0.2	3.6	0.7	VCCI – 1.1	14	14	51	54	15	15

Notes:

1. *I_{IL} is the input leakage current per I/O pin over recommended operating conditions where –0.3 V < VIN < VIL.*
2. *I_{IH} is the input leakage current per I/O pin over recommended operating conditions VIH < VIN < VCCI. Input current is larger when operating outside recommended ranges.*
3. *Currents are measured at 100°C junction temperature and maximum voltage.*
4. *Currents are measured at 125°C junction temperature.*

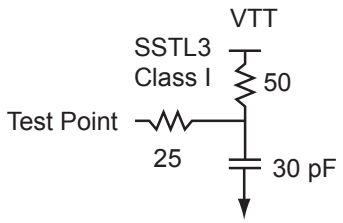


Figure 2-23 • AC Loading

Table 2-153 • AC Waveforms, Measuring Points, and Capacitive Loads

Input Low (V)	Input High (V)	Measuring Point* (V)	VREF (typ.) (V)	VTT (typ.) (V)	C_{LOAD} (pF)
VREF – 0.2	VREF + 0.2	1.5	1.5	1.485	30

*Note: *Measuring point = V_{trip}. See Table 2-29 on page 2-25 for a complete table of trip points.*

Timing Characteristics

Table 2-154 • SSTL3 Class I
Military-Case Conditions: T_J = 125°C, Worst-Case VCC = 1.14 V,
Worst-Case VCCI = 3.0 V, VREF = 1.5 V
Applicable to Pro I/Os for A3PE600L and A3PE3000L Only

Speed Grade	t_{DOUT}	t_{DP}	t_{DIN}	t_{PY}	t_{EOUT}	t_{ZL}	t_{ZH}	t_{LZ}	t_{HZ}	t_{ZLS}	t_{ZHS}	Units
Std.	0.80	2.29	0.05	2.00	0.52	2.32	1.82	–	–	2.32	1.82	ns
–1	0.68	1.95	0.05	1.71	0.44	1.98	1.55	–	–	1.98	1.55	ns

Note: For specific junction temperature and voltage supply levels, refer to Table 2-6 on page 2-6 for derating values.

Table 2-174 • Input Data Register Propagation Delays
Military-Case Conditions: T_J = 125°C, Worst-Case VCC = 1.425 V for A3P250 and A3P1000

Parameter	Description	–1	Std.	Units
t_{ICLKQ}	Clock-to-Q of the Input Data Register	0.29	0.34	ns
t_{ISUD}	Data Setup Time for the Input Data Register	0.32	0.37	ns
t_{IHD}	Data Hold Time for the Input Data Register	0.00	0.00	ns
t_{ISUE}	Enable Setup Time for the Input Data Register	0.45	0.53	ns
t_{IHE}	Enable Hold Time for the Input Data Register	0.00	0.00	ns
t_{ICLR2Q}	Asynchronous Clear-to-Q of the Input Data Register	0.55	0.64	ns
t_{IPRE2Q}	Asynchronous Preset-to-Q of the Input Data Register	0.55	0.64	ns
$t_{IREMCLR}$	Asynchronous Clear Removal Time for the Input Data Register	0.00	0.00	ns
$t_{IRECCLR}$	Asynchronous Clear Recovery Time for the Input Data Register	0.27	0.31	ns
$t_{IREMPRE}$	Asynchronous Preset Removal Time for the Input Data Register	0.00	0.00	ns
$t_{IRECPRE}$	Asynchronous Preset Recovery Time for the Input Data Register	0.27	0.31	ns
t_{IWCLR}	Asynchronous Clear Minimum Pulse Width for the Input Data Register	0.25	0.30	ns
t_{IWPRE}	Asynchronous Preset Minimum Pulse Width for the Input Data Register	0.25	0.30	ns
$t_{ICKMPWH}$	Clock Minimum Pulse Width HIGH for the Input Data Register	0.41	0.48	ns
$t_{ICKMPWL}$	Clock Minimum Pulse Width LOW for the Input Data Register	0.37	0.43	ns

Note: For specific junction temperature and voltage supply levels, refer to Table 2-7 on page 2-6 for derating values.

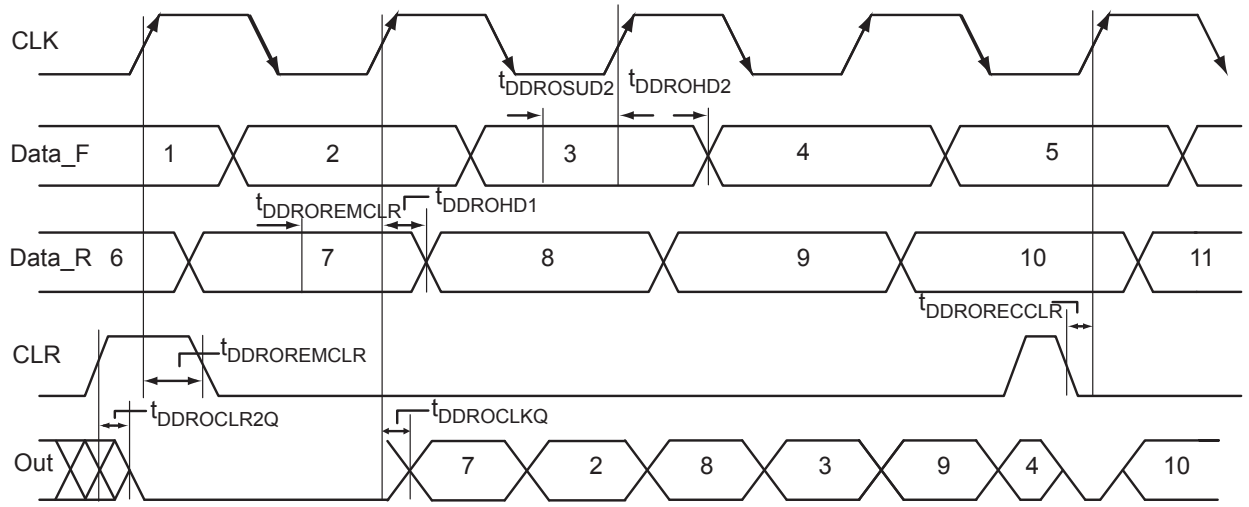


Figure 2-36 • **Output DDR Timing Diagram**

Timing Characteristics

Table 2-186 • **Output DDR Propagation Delays**
Military-Case Conditions: T_J = 125°C, Worst-Case VCC = 1.14 V for A3PE600L and A3PE3000L

Parameter	Description	–1	Std.	Units
$t_{DDROCLKQ}$	Clock-to-Out of DDR for Output DDR	0.97	1.14	ns
$t_{DDRISUD1}$	Data_F Data Setup for Output DDR	0.52	0.62	ns
$t_{DDROSUD2}$	Data_R Data Setup for Output DDR	0.52	0.62	ns
$t_{DDROHD1}$	Data_F Data Hold for Output DDR	0.00	0.00	ns
$t_{DDROHD2}$	Data_R Data Hold for Output DDR	0.00	0.00	ns
$t_{DDROCLR2Q}$	Asynchronous Clear-to-Out for Output DDR	1.11	1.30	ns
$t_{DDROREMCLR}$	Asynchronous Clear Removal Time for Output DDR	0.00	0.00	ns
$t_{DDRORECCLR}$	Asynchronous Clear Recovery Time for Output DDR	0.31	0.36	ns
$t_{DDROWCLR1}$	Asynchronous Clear Minimum Pulse Width for Output DDR	0.19	0.22	ns
$t_{DDROCKMPWH}$	Clock Minimum Pulse Width HIGH for the Output DDR	0.31	0.36	ns
$t_{DDROCKMPWL}$	Clock Minimum Pulse Width LOW for the Output DDR	0.28	0.32	ns
$F_{DDROMAX}$	Maximum Frequency for the Output DDR	160	160	MHz

Note: For specific junction temperature and voltage supply levels, refer to Table 2-6 on page 2-6 for derating values.

Table 2-191 • Combinatorial Cell Propagation Delays
Military-Case Conditions: T_J = 125°C, Worst-Case VCC = 1.425 V for A3P250 and A3P1000

Combinatorial Cell	Equation	Parameter	–1	Std.	Units
INV	Y = !A	t_{PD}	0.48	0.57	ns
AND2	Y = A · B	t_{PD}	0.57	0.67	ns
NAND2	Y = !(A · B)	t_{PD}	0.57	0.67	ns
OR2	Y = A + B	t_{PD}	0.59	0.69	ns
NOR2	Y = !(A + B)	t_{PD}	0.59	0.69	ns
XOR2	Y = A ⊕ B	t_{PD}	0.89	1.04	ns
MAJ3	Y = MAJ(A , B, C)	t_{PD}	0.84	0.99	ns
XOR3	Y = A ⊕ B ⊕ C	t_{PD}	1.05	1.24	ns
MUX2	Y = A !S + B S	t_{PD}	0.61	0.72	ns
AND3	Y = A · B · C	t_{PD}	0.68	0.79	ns

Note: For specific junction temperature and voltage supply levels, refer to Table 2-7 on page 2-6 for derating values.

Table 2-193 • Register Delays
Military-Case Conditions: T_J = 125°C, VCC = 1.425 V for A3PE600L and A3PE3000L

Parameter	Description	–1	Std.	Units
t_{CLKQ}	Clock-to-Q of the Core Register	0.58	0.69	ns
t_{SUD}	Data Setup Time for the Core Register	0.45	0.53	ns
t_{HD}	Data Hold Time for the Core Register	0.00	0.00	ns
t_{SUE}	Enable Setup Time for the Core Register	0.48	0.57	ns
t_{HE}	Enable Hold Time for the Core Register	0.00	0.00	ns
t_{CLR2Q}	Asynchronous Clear-to-Q of the Core Register	0.42	0.50	ns
t_{PRE2Q}	Asynchronous Preset-to-Q of the Core Register	0.42	0.50	ns
t_{REMCLR}	Asynchronous Clear Removal Time for the Core Register	0.00	0.00	ns
t_{RECCLR}	Asynchronous Clear Recovery Time for the Core Register	0.24	0.28	ns
t_{REMPRE}	Asynchronous Preset Removal Time for the Core Register	0.00	0.00	ns
t_{RECPRE}	Asynchronous Preset Recovery Time for the Core Register	0.24	0.28	ns
t_{WCLR}	Asynchronous Clear Minimum Pulse Width for the Core Register	0.30	0.34	ns
t_{WPRE}	Asynchronous Preset Minimum Pulse Width for the Core Register	0.30	0.34	ns
t_{CKMPWH}	Clock Minimum Pulse Width HIGH for the Core Register	0.56	0.64	ns
t_{CKMPWL}	Clock Minimum Pulse Width LOW for the Core Register	0.56	0.64	ns

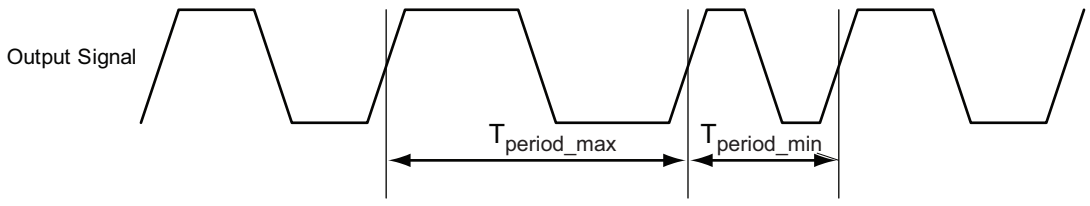
Note: For specific junction temperature and voltage supply levels, refer to Table 2-6 on page 2-6 for derating values.

Table 2-202 • Military ProASIC3/EL CCC/PLL Specification For Devices Operating at 1.5 V DC Core Voltage

Parameter	Min.	Typ.	Max.	Units
Clock Conditioning Circuitry Input Frequency f_{IN_CCC}	1.5		350	MHz
Clock Conditioning Circuitry Output Frequency f_{OUT_CCC}	0.75		350	MHz
Delay Increments in Programmable Delay Blocks [1, 2,3]		160		ps
Number of Programmable Values in Each Programmable Delay Block			32	
Serial Clock (SCLK) for Dynamic PLL[4]			110	MHz
Input cycle-to-cycle jitter (peak magnitude)			1.5	ns
Acquisition Time				
LockControl = 0			300	µs
LockControl = 1			6.0	ms
Tracking Jitter[5]				
LockControl = 0			1.6	ns
LockControl = 1			0.8	ns
Output Duty Cycle	48.5		51.5	%
Delay Range in Block: Programmable Delay 1 [1,2]	0.6		5.56	ns
Delay Range in Block: Programmable Delay 2 [1,2]	0.025		5.56	ns
Delay Range in Block: Fixed Delay [1,2]		2.2		ns
CCC Output Peak-to-Peak Period Jitter F_{CCC_OUT}	Max. Peak-to-Peak Period Jitter [6,7]			
	SSO ≤ 2	SSO ≤ 4	SSO ≤ 8	SSO ≤ 16
0.75 MHz to 50 MHz	0.50%	0.50%	0.70%	1.00%
50 MHz to 250 MHz	1.00%	3.00%	5.00%	9.00%
250 MHz to 350 MHz	2.50%	4.00%	6.00%	12.00%

Notes:

1. *This delay is a function of voltage and temperature. See Table 2-6 on page 2-6 for deratings.*
2. *T_J = 25°C, VCC = 1.5 V.*
3. *When the CCC/PLL core is generated by Mircosemi core generator software, not all delay values of the specified delay increments are available. Refer to the Libero online help associated with the core for more information.*
4. *Maximum value obtained for a -1 speed grade device in worst-case military conditions. For specific junction temperature and voltage supply levels, refer to Table 2-6 on page 2-6 for derating values.*
5. *Tracking jitter is defined as the variation in clock edge position of PLL outputs with reference to PLL input clock edge. Tracking jitter does not measure the variation in PLL output period, which is covered by period jitter parameter.*
6. *Measurements done with LVTTL 3.3 V, 8 mA I/O drive strength and high slew rate. VCC/VCCPLL = 1.425 V, VQ/PQ/TQ type of packages, 20 pF load.*
7. *Switching I/Os are placed outside of the PLL bank.*



Note: Peak-to-peak jitter measurements are defined by $T_{peak\text{-}to\text{-}peak} = T_{period\_max} - T_{period\_min}$.

Figure 2-42 • Peak-to-Peak Jitter Definition

Timing Characteristics

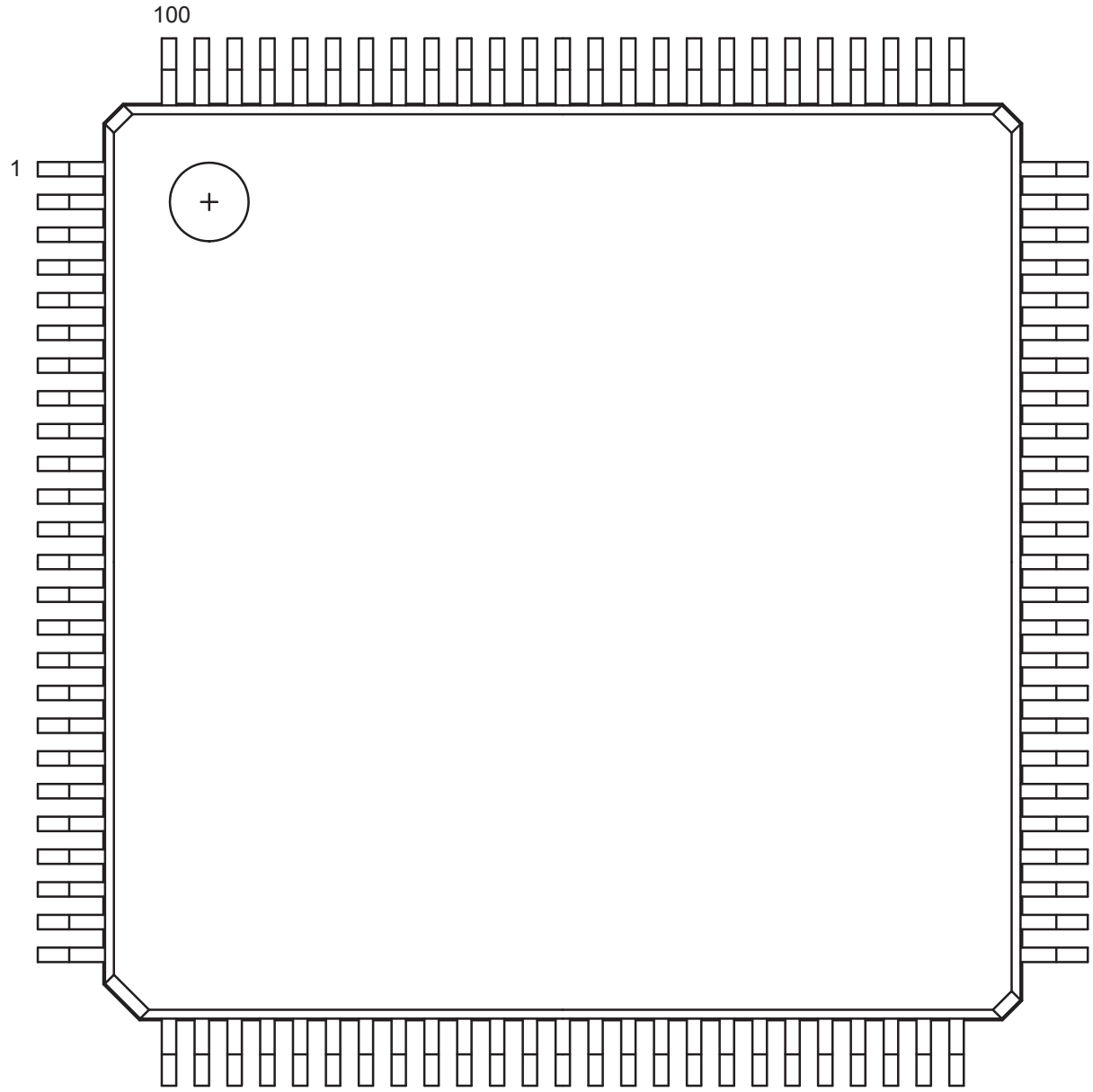
Table 2-209 • FIFO Worst Military-Case Conditions: T_J = 125°C, VCC = 1.14 V for A3PE600L and A3PE3000L

Parameter	Description	–1	Std.	Units
t_{ENS}	REN, WEN Setup Time	1.91	2.24	ns
t_{ENH}	REN, WEN Hold Time	0.03	0.03	ns
t_{BKS}	BLK Setup Time	0.40	0.47	ns
t_{BKH}	BLK Hold Time	0.00	0.00	ns
t_{DS}	Input Data (WD) Setup Time	0.25	0.30	ns
t_{DH}	Input Data (WD) Hold Time	0.00	0.00	ns
t_{CKQ1}	Clock HIGH to New Data Valid on RD (flow-through)	3.26	3.84	ns
t_{CKQ2}	Clock HIGH to New Data Valid on RD (pipelined)	1.24	1.46	ns
t_{RCKEF}	RCLK HIGH to Empty Flag Valid	2.38	2.80	ns
t_{WCKFF}	WCLK HIGH to Full Flag Valid	2.26	2.66	ns
t_{CKAF}	Clock HIGH to Almost Empty/Full Flag Valid	8.57	10.08	ns
t_{RSTFG}	RESET LOW to Empty/Full Flag Valid	2.34	2.76	ns
t_{RSTAF}	RESET LOW to Almost Empty/Full Flag Valid	8.48	9.97	ns
t_{RSTBQ}	RESET LOW to Data Out LOW on RD (flow-through)	1.28	1.50	ns
	RESET LOW to Data Out LOW on RD (pipelined)	1.28	1.50	ns
$t_{REMRSTB}$	RESET Removal	0.40	0.47	ns
$t_{RECRSTB}$	RESET Recovery	2.08	2.44	ns
$t_{MPWRSTB}$	RESET Minimum Pulse Width	0.66	0.76	ns
t_{CYC}	Clock Cycle Time	6.08	6.99	ns
F_{MAX}	Maximum Frequency for FIFO	164	143	MHz

Note: For specific junction temperature and voltage supply levels, refer to Table 2-6 on page 2-6 for derating values.

4 – Package Pin Assignments

VQ100



Note: This is the top view of the package.

Note

For Package Manufacturing and Environmental information, visit the Resource Center at http://www.microsemi.com/products/fpga-soc/solutions.

Datasheet Categories

Categories

In order to provide the latest information to designers, some datasheet parameters are published before data has been fully characterized from silicon devices. The data provided for a given device, as highlighted in the "Military ProASIC3/EL Device Status" table on page II, is designated as either "Product Brief," "Advance," "Preliminary," or "Production." The definitions of these categories are as follows:

Product Brief

The product brief is a summarized version of a datasheet (advance or production) and contains general product information. This document gives an overview of specific device and family information.

Advance

This version contains initial estimated information based on simulation, other products, devices, or speed grades. This information can be used as estimates, but not for production. This label only applies to the DC and Switching Characteristics chapter of the datasheet and will only be used when the data has not been fully characterized.

Preliminary

The datasheet contains information based on simulation and/or initial characterization. The information is believed to be correct, but changes are possible.

Unmarked (production)

This version contains information that is considered to be final.

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