

## Features

- 5 ns pin-to-pin logic delays
- System frequency up to 178 MHz
- 36 macrocells with 800 usable gates
- Available in small footprint packages
  - 44-pin PLCC (34 user I/O pins)
  - 44-pin VQFP (34 user I/O pins)
  - 48-pin CSP (36 user I/O pins)
  - 64-pin VQFP (36 user I/O pins)
- Optimized for high-performance 3.3V systems
  - Low power operation
  - 5V tolerant I/O pins accept 5 V, 3.3V, and 2.5V signals
  - 3.3V or 2.5V output capability
  - Advanced 0.35 micron feature size CMOS FastFLASH™ technology
- Advanced system features
  - In-system programmable
  - Superior pin-locking and routability with FastCONNECT II™ switch matrix
  - Extra wide 54-input Function Blocks
  - Up to 90 product-terms per macrocell with individual product-term allocation
  - Local clock inversion with three global and one product-term clocks
  - Individual output enable per output pin
  - Input hysteresis on all user and boundary-scan pin inputs
  - Bus-hold circuitry on all user pin inputs
  - Full IEEE Standard 1149.1 boundary-scan (JTAG)
- Fast concurrent programming
- Slew rate control on individual outputs
- Enhanced data security features
- Excellent quality and reliability
  - Endurance exceeding 10,000 program/erase cycles
  - 20 year data retention
  - ESD protection exceeding 2,000V
- Pin-compatible with 5V-core XC9536 device in the 44-pin PLCC package and the 48-pin CSP package

## Description

The XC9536XL is a 3.3V CPLD targeted for high-performance, low-voltage applications in leading-edge communi-

cations and computing systems. It is comprised of two 54V18 Function Blocks, providing 800 usable gates with propagation delays of 5 ns. See [Figure 2](#) for architecture overview.

## Power Estimation

Power dissipation in CPLDs can vary substantially depending on the system frequency, design application and output loading. To help reduce power dissipation, each macrocell in a XC9500XL device may be configured for low-power mode (from the default high-performance mode). In addition, unused product-terms and macrocells are automatically deactivated by the software to further conserve power.

For a general estimate of  $I_{CC}$ , the following equation may be used:

$$I_{CC} \text{ (mA)} = MC_{HP}(0.5) + MC_{LP}(0.3) + MC(0.0045 \text{ mA/MHz}) f$$

Where:

$MC_{HP}$  = Macrocells in high-performance (default) mode

$MC_{LP}$  = Macrocells in low-power mode

$MC$  = Total number of macrocells used

$f$  = Clock frequency (MHz)

This calculation is based on typical operating conditions using a pattern of 16-bit up/down counters in each Function Block with no output loading. The actual  $I_{CC}$  value varies with the design application and should be verified during normal system operation.

[Figure 1](#) shows the above estimation in a graphical form.

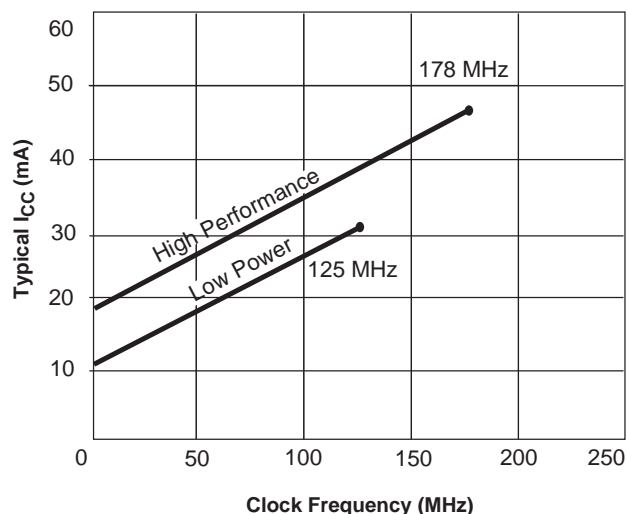
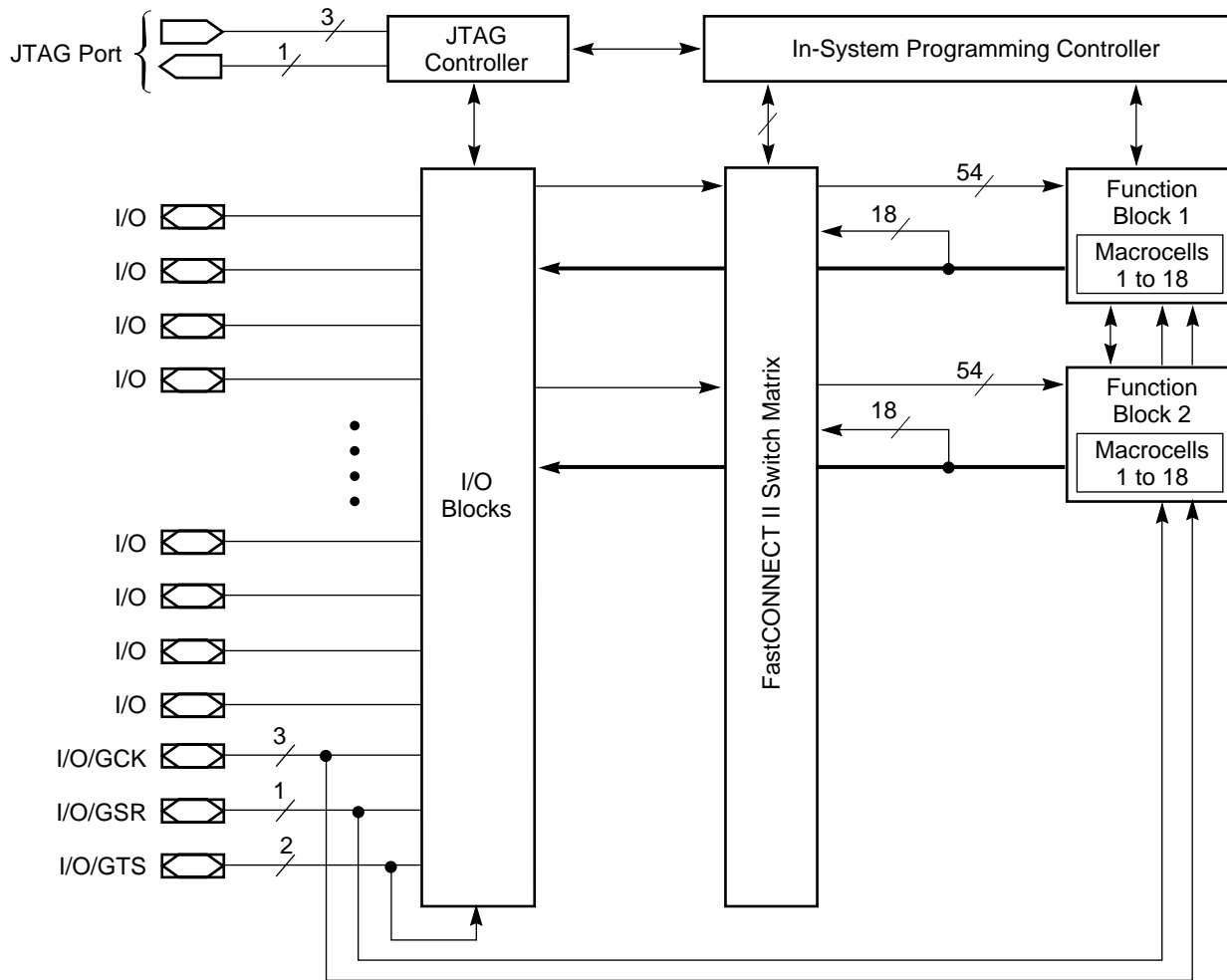


Figure 1: Typical  $I_{CC}$  vs. Frequency for XC9536XL



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**Figure 2: XC9536XL Architecture**  
 Function Block outputs (indicated by the bold line) drive the I/O Blocks directly.

## Absolute Maximum Ratings

Symbol	Description	Value	Units
$V_{CC}$	Supply voltage relative to GND	-0.5 to 4.0	V
$V_{IN}$	Input voltage relative to GND <sup>(1)</sup>	-0.5 to 5.5	V
$V_{TS}$	Voltage applied to 3-state output <sup>(1)</sup>	-0.5 to 5.5	V
$T_{STG}$	Storage temperature (ambient)	-65 to +150	°C
$T_{SOL}$	Maximum soldering temperature (10s @ 1/16 in. = 1.5 mm)	+260	°C
$T_J$	Junction temperature	+150	°C

**Notes:**

- Maximum DC undershoot below GND must be limited to either 0.5V or 10 mA, whichever is easier to achieve. During transitions, the device pins may undershoot to -2.0 V or overshoot to +7.0V, provided this over- or undershoot lasts less than 10 ns and with the forcing current being limited to 200 mA.
- Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those listed under Operating Conditions is not implied. Exposure to Absolute Maximum Ratings conditions for extended periods of time may affect device reliability.

## Recommended Operation Conditions

Symbol	Parameter	Min	Max	Units	
$V_{CCINT}$	Supply voltage for internal logic and input buffers	Commercial $T_A = 0^{\circ}\text{C}$ to $70^{\circ}\text{C}$	3.0	3.6	V
		Industrial $T_A = -40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$	3.0	3.6	V
$V_{CCIO}$	Supply voltage for output drivers for 3.3V operation	3.0	3.6	V	
	Supply voltage for output drivers for 2.5V operation	2.3	2.7	V	
$V_{IL}$	Low-level input voltage	0	0.80	V	
$V_{IH}$	High-level input voltage	2.0	5.5	V	
$V_O$	Output voltage	0	$V_{CCIO}$	V	

## Quality and Reliability Characteristics

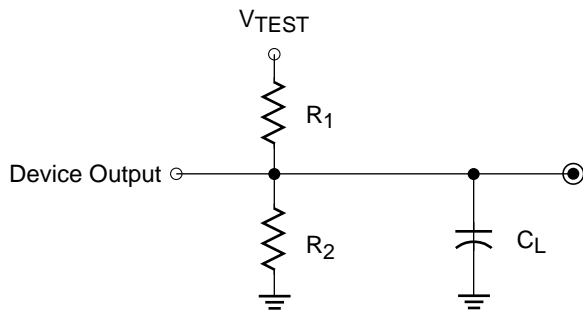
Symbol	Parameter	Min	Max	Units
$T_{DR}$	Data Retention	20	-	Years
$N_{PE}$	Program/Erase Cycles (Endurance)	10,000	-	Cycles
$V_{ESD}$	Electrostatic Discharge (ESD)	2,000	-	Volts

## DC Characteristic Over Recommended Operating Conditions

Symbol	Parameter	Test Conditions	Min	Max	Units
$V_{OH}$	Output high voltage for 3.3V outputs	$I_{OH} = -4.0$ mA	2.4		V
	Output high voltage for 2.5V outputs	$I_{OH} = -500$ $\mu\text{A}$	90% $V_{CCIO}$		V
$V_{OL}$	Output low voltage for 3.3V outputs	$I_{OL} = 8.0$ mA	-	0.4	V
	Output low voltage for 2.5V outputs	$I_{OL} = 500$ $\mu\text{A}$	-	0.4	V
$I_{IL}$	Input leakage current	$V_{CC} = \text{Max}$ $V_{IN} = \text{GND or } V_{CC}$	-	$\pm 10$	$\mu\text{A}$
$I_{IH}$	I/O high-Z leakage current	$V_{CC} = \text{Max}$ $V_{IN} = \text{GND or } V_{CC}$	-	$\pm 10$	$\mu\text{A}$
$C_{IN}$	I/O capacitance	$V_{IN} = \text{GND}$ $f = 1.0$ MHz	-	10	pF
$I_{CC}$	Operating supply current (low power mode, active)	$V_I = \text{GND}$ , No load $f = 1.0$ MHz	10 (Typical)		mA

## AC Characteristics

Symbol	Parameter	XC9536XL-5		XC9536XL-7		XC9536XL-10		Units
		Min	Max	Min	Max	Min	Max	
$T_{PD}$	I/O to output valid	-	5.0	-	7.5	-	10.0	ns
$T_{SU}$	I/O setup time before GCK	3.7	-	4.8	-	6.5	-	ns
$T_H$	I/O hold time after GCK	0	-	0	-	0	-	ns
$T_{CO}$	GCK to output valid	-	3.5	-	4.5	-	5.8	ns
$f_{SYSTEM}$	Multiple FB internal operating frequency	-	178.6	-	125	-	100	MHz
$T_{PSU}$	I/O setup time before p-term clock input	1.7	-	1.6	-	2.1	-	ns
$T_{PH}$	I/O hold time after p-term clock input	2.0	-	3.2	-	4.4	-	ns
$T_{PCO}$	P-term clock output valid	-	5.5	-	7.7	-	10.2	ns
$T_{OE}$	GTS to output valid	-	4.0	-	5.0	-	7.0	ns
$T_{OD}$	GTS to output disable	-	4.0	-	5.0	-	7.0	ns
$T_{POE}$	Product term OE to output enabled	-	7.0	-	9.5	-	11.0	ns
$T_{POD}$	Product term OE to output disabled	-	7.0	-	9.5	-	11.0	ns
$T_{AO}$	GSR to output valid	-	10.0	-	12.0	-	14.5	ns
$T_{PAO}$	P-term S/R to output valid	-	10.5	-	12.6	-	15.3	ns
$T_{WLH}$	GCK pulse width (High or Low)	2.8	-	4.0	-	4.5	-	ns
$T_{PLH}$	P-term clock pulse width (High or Low)	5.0	-	6.5	-	7.0	-	ns



Output Type	$V_{CCIO}$	$V_{TEST}$	$R_1$	$R_2$	$C_L$
	3.3V	3.3V	320 $\Omega$	360 $\Omega$	35 pF
	2.5V	2.5V	250 $\Omega$	660 $\Omega$	35 pF

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Figure 3: AC Load Circuit

## Internal Timing Parameters

Symbol	Parameter	XC9536XL-5		XC9536XL-7		XC9536XL-10		Units
		Min	Max	Min	Max	Min	Max	
<b>Buffer Delays</b>								
$T_{IN}$	Input buffer delay	-	1.5	-	2.3	-	3.5	ns
$T_{GCK}$	GCK buffer delay	-	1.1	-	1.5	-	1.8	ns
$T_{GSR}$	GSR buffer delay	-	2.0	-	3.1	-	4.5	ns
$T_{GTS}$	GTS buffer delay	-	4.0	-	5.0	-	7.0	ns
$T_{OUT}$	Output buffer delay	-	2.0	-	2.5	-	3.0	ns
$T_{EN}$	Output buffer enable/disable delay	-	0	-	0	-	0	ns
<b>Product Term Control Delays</b>								
$T_{PTCK}$	Product term clock delay	-	1.6	-	2.4	-	2.7	ns
$T_{PTSR}$	Product term set/reset delay	-	1.0	-	1.4	-	1.8	ns
$T_{PTTS}$	Product term 3-state delay	-	5.5	-	7.2	-	7.5	ns
<b>Internal Register and Combinatorial Delays</b>								
$T_{PDI}$	Combinatorial logic propagation delay	-	0.5	-	1.3	-	1.7	ns
$T_{SUI}$	Register setup time	2.3	-	2.6	-	3.0	-	ns
$T_{HI}$	Register hold time	1.4	-	2.2	-	3.5	-	ns
$T_{ECSU}$	Register clock enable setup time	2.3	-	2.6	-	3.0	-	ns
$T_{ECHO}$	Register clock enable hold time	1.4	-	2.2	-	3.5	-	ns
$T_{COI}$	Register clock to output valid time	-	0.4	-	0.5	-	1.0	ns
$T_{AOI}$	Register async. S/R to output delay	-	6.0	-	6.4	-	7.0	ns
$T_{RAI}$	Register async. S/R recover before clock	5.0		7.5		10.0		ns
$T_{LOGI}$	Internal logic delay	-	1.0	-	1.4	-	1.8	ns
$T_{LOGILP}$	Internal low power logic delay	-	5.0	-	6.4	-	7.3	ns
<b>Feedback Delays</b>								
$T_F$	FastCONNECT II feedback delay	-	1.9	-	3.5	-	4.2	ns
<b>Time Adders</b>								
$T_{PTA}$	Incremental product term allocator delay	-	0.7	-	0.8	-	1.0	ns
$T_{SLEW}$	Slew-rate limited delay	-	3.0	-	4.0	-	4.5	ns

## XC9536XL I/O Pins

Function Block	Macro-cell	PC44	VQ44	CS48	VQ64	BScan Order	Function Block	Macro-cell	PC44	VQ44	CS48	VQ64	BScan Order
1	1	2	40	D6	9	105	2	1	1	39	D7	8	51
1	2	3	41	C7	10	102	2	2	44	38	E5	7	48
1	3	5 <sup>(1)</sup>	43 <sup>(1)</sup>	B7 <sup>(1)</sup>	15 <sup>(1)</sup>	99	2	3	42 <sup>(1)</sup>	36 <sup>(1)</sup>	E6 <sup>(1)</sup>	5 <sup>(1)</sup>	45
1	4	4	42	C6	11	96	2	4	43	37	E7	6	42
1	5	6 <sup>(1)</sup>	44 <sup>(1)</sup>	B6 <sup>(1)</sup>	16 <sup>(1)</sup>	93	2	5	40 <sup>(1)</sup>	34 <sup>(1)</sup>	F6 <sup>(1)</sup>	2 <sup>(1)</sup>	39
1	6	8	2	A6	19	90	2	6	39 <sup>(1)</sup>	33 <sup>(1)</sup>	G7 <sup>(1)</sup>	64 <sup>(1)</sup>	36
1	7	7 <sup>(1)</sup>	1 <sup>(1)</sup>	A7 <sup>(1)</sup>	17 <sup>(1)</sup>	87	2	7	38	32	G6	63	33
1	8	9	3	C5	20	84	2	8	37	31	F5	62	30
1	9	11	5	B5	22	81	2	9	36	30	G5	61	27
1	10	12	6	A4	24	78	2	10	35	29	F4	60	24
1	11	13	7	B4	25	75	2	11	34	28	G4	57	21
1	12	14	8	A3	27	72	2	12	33	27	E3	56	18
1	13	18	12	B2	33	69	2	13	29	23	F2	50	15
1	14	19	13	B1	35	66	2	14	28	22	G1	48	12
1	15	20	14	C2	36	63	2	15	27	21	F1	45	9
1	16	22	16	C3	38	60	2	16	26	20	E2	44	6
1	17	24	18	D2	42	57	2	17	25	19	E1	43	3
1	18	-	-	D3	39	54	2	18	-	-	E4	49	0

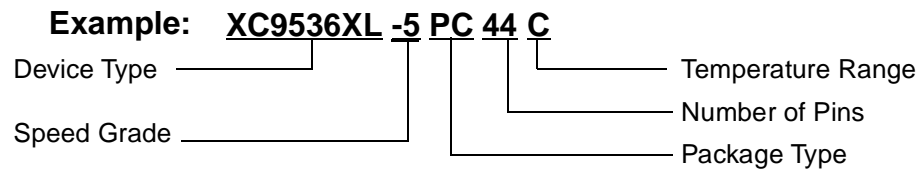
### Notes:

1. Global control pin.

## XC9536XL Global, JTAG and Power Pins

Pin Type	PC44	VQ44	CS48	VQ64
I/O/GCK1	5	43	B7	15
I/O/GCK2	6	44	B6	16
I/O/GCK3	7	1	A7	17
I/O/GTS1	42	36	E6	5
I/O/GTS2	40	34	F6	2
I/O/GSR	39	33	G7	64
TCK	17	11	A1	30
TDI	15	9	B3	28
TDO	30	24	G2	53
TMS	16	10	A2	29
V <sub>CCINT</sub> 3.3V	21, 41	15, 35	C1, F7	3, 37
V <sub>CCIO</sub> 2.5V/3.3V	32	26	G3	55
GND	10, 23, 31	4, 17, 25	A5, D1, F3	21, 41, 54
No Connects	-	-	C4, D4	1, 4, 12, 13, 14, 18, 23, 26, 31, 32, 34, 40, 46, 47, 51, 52, 58, 59

## Ordering Information



### Device Ordering Options

Speed		Package		Temperature	
-10	10 ns pin-to-pin delay	PC44	44-pin Plastic Lead Chip Carrier (PLCC)	C = Commercial	T <sub>A</sub> = 0°C to +70°C
-7	7.5 ns pin-to-pin delay	VQ44	44-pin Quad Flat Pack (VQFP)	I = Industrial	T <sub>A</sub> = -40°C to +85°C
-5	5 ns pin-to-pin delay	CS48	48-pin Chip Scale Package		
-4	4 ns pin-to-pin delay	VQ64	64-pin Quad Flat Pack (VQFP)		

### Component Availability

Pins		44	44	48	64
Type		Plastic PLCC	Plastic VQFP	Plastic CSP	Plastic VQFP
Code		PC44	VQ44	CS48	VQ64
XC9536XL	-10	C, I	C, I	C, I	C, I
	-7	C, I	C, I	C, I	C, I
	-5	C	C	C	C

**Notes:**

1. C = Commercial (T<sub>A</sub> = 0°C to +70°C); I = Industrial (T<sub>A</sub> = -40°C to +85°C).

### Revision History

The following table shows the revision history for this document.

Date	Version	Revision
09/28/98	1.0	Initial Xilinx release.
08/28/00	1.1	Added VQ44 package.
06/25/01	1.2	Removed -4 device. Added C4 and D4 pins to CS48 No Connects in pinout table. Added industrial availability to -7 device.