

## Features

- Guaranteed to meet full electrical specifications over  $T_A = -40^\circ\text{C}$  to  $+125^\circ\text{C}$
- Technology: 0.35  $\mu\text{m}$  EEPROM process
- Full Boundary Scan Test (IEEE 1149.1) for flexible in-system device and system testing
- Fast programming times in production saves time and money
  - Increases system reliability through reduced device handling
- High-speed pin-to-pin delays of 12 ns (87 MHz)
- Slow rate control per output to reduce EMI
- 100% routable which enables all device resources to be utilized
- Refer to XPLA3 Family data sheet (DS012) for architecture description
- Refer to XCR3384XL data sheet (DS024) for pin descriptions

## Description

The CoolRunner™ XCR3384XL-Q CPLD Automotive IQ product is targeted for low power systems that include portable, handheld, automotive, and power sensitive applications. This device includes Fast Zero Power™ (FZP) design technology that combines low power and high speed. With this design technique, the XCR3384XL-Q delivers low standby current without the need for "turbo bits" or other power down schemes. By replacing conventional sense amplifier methods for implementing product terms (a technique that has been used in PLDs since the bipolar era) with a cascaded chain of pure CMOS gates, the dynamic power is also substantially lower than any other CPLD. CoolRunner devices are the only TotalCMOS PLDs, as they use both a CMOS process technology and the patented full CMOS FZP design technique.

The CoolRunner XCR3384XL-Q employs a full PLA structure for logic allocation within a function block. The PLA provides maximum flexibility and logic density, with superior pin locking capability, while maintaining deterministic timing.

The CoolRunner XCR3384XL-Q is supported by WebPACK™ and WebFITTER™ from Xilinx and industry standard CAE tools (Cadence/OrCAD, Exemplar Logic, Mentor,

Synopsys, ViewLogic, and Synplicity), using text (ABEL, VHDL, Verilog) and schematic capture design entry. Design verification uses industry standard simulators for functional and timing simulation. Development is supported on personal computer, Sparc, and HP platforms.

The XCR3384XL-Q features also include industry-standard, IEEE 1149.1, JTAG interface through which boundary-scan testing and In-System Programming (ISP) and reprogramming of the device can occur. This device is electrically reprogrammable using industry standard device programmers.

Table 1: CoolRunner XCR3384XL-Q

	XCR3384XL-Q
Macrocells	384
Usable Gates	9,000
Registers	384
$F_{\text{SYSTEM}}$ (MHz)	87
User I/O (208-pin PQFP)	172

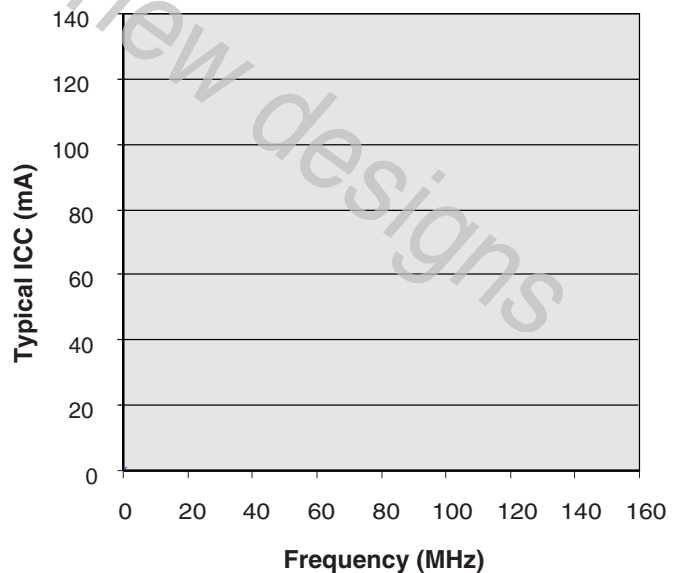


Figure 1: XCR3384XL Typical  $I_{CC}$  vs. Frequency at  $V_{CC} = 3.3\text{V}$ ,  $25^\circ\text{C}$

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Table 2: Typical  $I_{CC}$  vs. Frequency at  $V_{CC} = 3.3\text{V}$ ,  $25^\circ\text{C}$

Frequency (MHz)	0	1	10	20	40	60	80	100	120	140
Typical $I_{CC}$ (mA)	0.02	2.2	24.4	42.4	82.6	123.0	155.6	187.8	227.5	258.1

## Absolute Maximum Ratings<sup>(1)</sup>

Symbol	Parameter	Min.	Max.	Unit
$V_{CC}$	Supply voltage <sup>(2)</sup> relative to GND	-0.5	4.0	V
$V_I$	Input voltage <sup>(3)</sup> relative to GND	-0.5	5.5 <sup>(4)</sup>	V
$I_{OUT}$	Output current, per pin	-100	100	mA
$T_J$	Maximum junction temperature	-40	150	°C
$T_{STR}$	Storage temperature	-65	150	°C

### Notes:

- Stresses above those listed may cause malfunction or permanent damage to the device. This is a stress rating only. Functional operation at these or any other condition above those indicated in the operational and programming specification is not implied.
- The chip supply voltage must rise monotonically.
- 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 -2.0V 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.
- External I/O voltage may not exceed  $V_{CC}$  by 4.0V.

## Recommended Operating Conditions

Symbol	Parameter	Min.	Max.	Unit
$T_A$	Ambient temperature	-40	+125	°C
$V_{CC}$	Supply voltage	3.0	3.6	V
$V_{IL}$	Low-level input voltage	0	0.8	V
$V_{IH}$	High-level input voltage	2.0	5.5	V
$V_O$	Output voltage	0	$V_{CC}$	V
$T_R$	Input rise time	-	20	ns
$T_F$	Input fall time	-	20	ns

## Quality and Reliability Characteristics

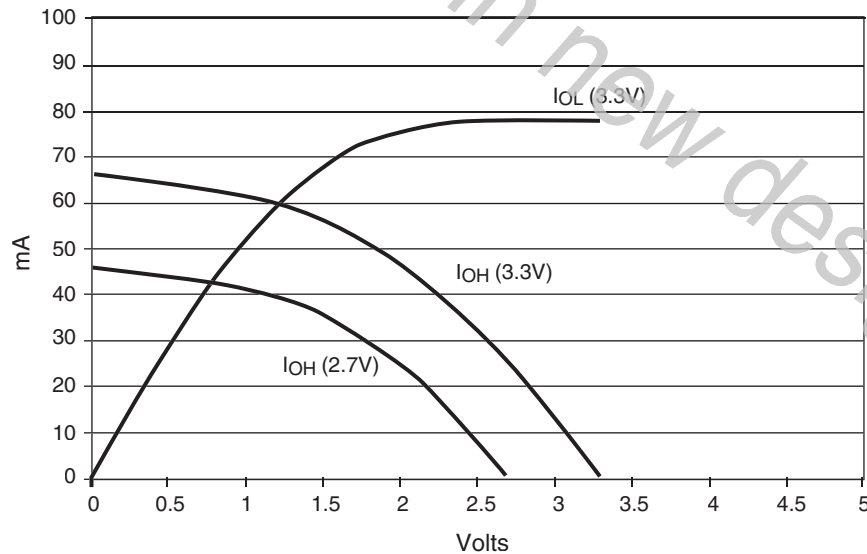
Symbol	Parameter	Min	Max	Units
$T_{DR}$	Data retention	20	-	Years
$N_{PE}$	Program/erase cycles (Endurance) @ $T_A = 70^\circ\text{C}$	10,000	-	Cycles

## DC Electrical Characteristics Over Recommended Operating Conditions

Symbol	Parameter	Test Conditions	Min.	Max.	Unit
V <sub>OH</sub> <sup>(1)</sup>	Output High voltage	I <sub>OH</sub> = -500 μA	90%V <sub>CC</sub> <sup>(2)</sup>	-	V
		V <sub>CC</sub> = 3.0V, I <sub>OH</sub> = -8 mA	2.4	-	V
V <sub>OL</sub>	Output Low voltage	I <sub>OL</sub> = 8 mA	-	0.4	V
I <sub>IL</sub> <sup>(3)</sup>	Input leakage current	V <sub>IN</sub> = GND or V <sub>CC</sub>	-10	10	μA
I <sub>IH</sub> <sup>(3)</sup>	I/O High-Z leakage current	V <sub>IN</sub> = GND or V <sub>CC</sub>	-10	10	μA
I <sub>CCSB</sub>	Standby current	V <sub>CC</sub> = 3.6V	-	10	mA
I <sub>CC</sub>	Dynamic current <sup>(4)</sup>	f = 1 MHz	-	15	mA
		f = 50 MHz	-	150	mA
C <sub>IN</sub>	Input pin capacitance <sup>(5)</sup>	f = 1 MHz	-	8	pF
C <sub>CLK</sub>	Clock input capacitance <sup>(5)</sup>	f = 1 MHz	-	12	pF
C <sub>I/O</sub>	I/O pin capacitance <sup>(5)</sup>	f = 1 MHz	-	10	pF

**Notes:**

1. See Figure 2 for output drive characteristics of the XPLA3 family.
2. This parameter guaranteed by design and characterization, not by testing.
3. Typical leakage current is less than 1 μA.
4. This parameter measured with a 16-bit, resettable up/down counter loaded into every function block, with all outputs disabled and unloaded. Inputs are tied to V<sub>CC</sub> or ground. This parameter guaranteed by design and characterization, not testing.
5. Typical values, not tested.



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Figure 2: Typical I/V Curve for the XPLA3 Family, 3.3V, 25°C

## AC Electrical Characteristics Over Recommended Operating Conditions<sup>(1)</sup>

Symbol	Parameter	-12		Unit
		Min.	Max.	
T <sub>PD1</sub>	Propagation delay time (single p-term)	-	10.8	ns
T <sub>PD2</sub>	Propagation delay time (OR array)	-	12.0	ns
T <sub>CO</sub>	Clock to output (global synchronous pin clock)	-	6.9	ns
T <sub>SUF</sub>	Setup time (fast input register)	3.0	-	ns
T <sub>SU1</sub> <sup>(2)</sup>	Setup time (single p-term)	6.7	-	ns
T <sub>SU2</sub>	Setup time (OR array)	7.9	-	ns
T <sub>H</sub> <sup>(2)</sup>	Hold time	0.0	-	ns
T <sub>WLH</sub> <sup>(2)</sup>	Global Clock pulse width (High or Low)	5.0	-	ns
T <sub>PLH</sub> <sup>(2)</sup>	P-term clock pulse width	7.5	-	ns
T <sub>R</sub> <sup>(2)</sup>	Input rise time	-	20.0	ns
T <sub>L</sub> <sup>(2)</sup>	Input fall time	-	20.0	ns
f <sub>SYSTEM</sub> <sup>(2)</sup>	Maximum system frequency	-	87	MHz
T <sub>CONFIG</sub> <sup>(2)</sup>	Configuration time <sup>(3)</sup>	-	200	μs
T <sub>INIT</sub>	ISP initialization time	-	200	μs
T <sub>POE</sub> <sup>(2)</sup>	P-term OE to output enabled	-	13.0	ns
T <sub>POD</sub> <sup>(2)</sup>	P-term OE to output disabled <sup>(4)</sup>	-	13.0	ns
T <sub>PCO</sub> <sup>(2)</sup>	P-term clock to output	-	12.4	ns
T <sub>PAO</sub> <sup>(2)</sup>	P-term set/reset to output valid	-	13.0	ns

### Notes:

1. Specifications measured with one output switching.
2. These parameters guaranteed by design and/or characterization, not testing.
3. Typical current draw during configuration is 3 mA at 3.6V.
4. Output C<sub>L</sub> = 5 pF.

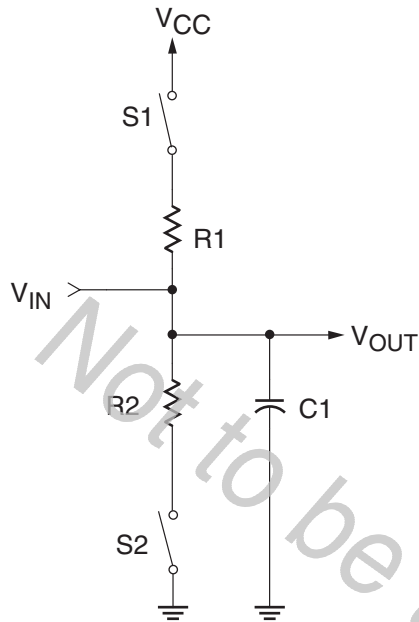
## Internal Timing Parameters<sup>(1)</sup>

Symbol	Parameter	-12		Unit
		Min.	Max.	
<b>Buffer Delays</b>				
T <sub>IN</sub>	Input buffer delay	-	4.0	ns
T <sub>FIN</sub>	Fast Input buffer delay	-	3.3	ns
T <sub>GCK</sub>	Global Clock buffer delay	-	1.5	ns
T <sub>OUT</sub>	Output buffer delay	-	3.8	ns
T <sub>EN</sub>	Output buffer enable/disable delay	-	6.0	ns
<b>Internal Register, Product Term, and Combinatorial Delays</b>				
T <sub>LDI</sub>	Latch transparent delay	-	2.0	ns
T <sub>SUI</sub>	Register setup time	1.2	-	ns
T <sub>HI</sub>	Register hold time	0.7	-	ns
T <sub>ECSU</sub>	Register clock enable setup time	3.0	-	ns
T <sub>ECHO</sub>	Register clock enable hold time	5.5	-	ns
T <sub>COI</sub>	Register clock to output delay	-	1.6	ns
T <sub>AOI</sub>	Register async. S/R to output delay	-	2.2	ns
T <sub>RAI</sub>	Register async. recovery	-	8.0	ns
T <sub>PTCK</sub>	Product term clock delay	-	3.0	ns
T <sub>LOGI1</sub>	Internal logic delay (single p-term)	-	3.0	ns
T <sub>LOGI2</sub>	Internal logic delay (PLA OR term)	-	4.2	ns
<b>Feedback Delays</b>				
T <sub>F</sub>	ZIA delay	-	5.0	ns
<b>Time Adders</b>				
T <sub>LOGI3</sub>	Fold-back NAND delay	-	3.0	ns
T <sub>UDA</sub>	Universal delay	-	3.5	ns
T <sub>SLEW</sub>	Slew rate limited delay	-	6.0	ns

### Notes:

1. These parameters guaranteed by design and characterization, not testing.

## Switching Characteristics



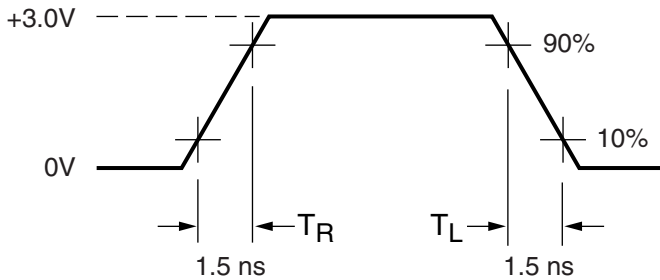
Component	Values
R1	390Ω
R2	390Ω
C1	35 pF

Measurement	S1	S2
T <sub>POE</sub> (High)	Open	Closed
T <sub>POE</sub> (Low)	Closed	Open
T <sub>P</sub>	Closed	Closed

**Note:** For T<sub>POD</sub>, C1 = 5 pF. Delay measured at output level of V<sub>OL</sub> + 300 mV, V<sub>OH</sub> - 300 mV.

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Figure 3: Typical AC Load Circuit



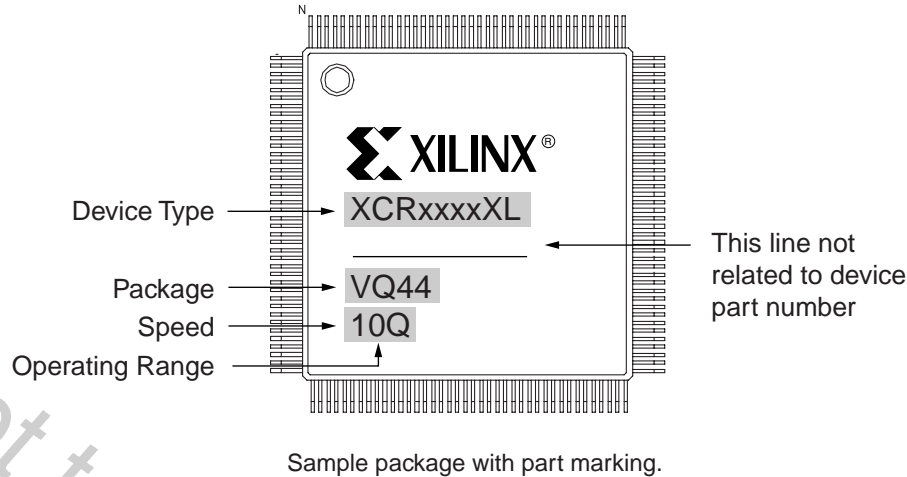
**Measurements:**

All circuit delays are measured at the +1.5V level of inputs and outputs, unless otherwise specified.

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Figure 4: Typical Voltage Waveform

## Device Part Marking



## Ordering Combination Information

Device Ordering and Part Marking Number	Speed (pin-to-pin delay)	Pkg. Symbol	No. of Pins	Package Type	Operating Range <sup>(1)</sup>
XCR3384XL-12PQ208Q	12 ns	PQ208	208-pin	Plastic Quad Flat Pack (PQFP)	Q

**Notes:**

1. Q = Automotive:  $T_A = -40^\circ$  to  $+125^\circ\text{C}$

## Revision History

The following table shows the revision history for this document.

Date	Version	Revision
02/14/03	1.0	Initial Xilinx release.
10/18/04	1.1	Added "Not to be used in new designs" watermark; moved to "Mature Products"