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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	32256
Number of Logic Elements/Cells	-
Total RAM Bits	294912
Number of I/O	586
Number of Gates	2000000
Voltage - Supply	1.425V ~ 1.575V
Mounting Type	Surface Mount
Operating Temperature	-40°C ~ 85°C (TA)
Package / Case	896-BGA
Supplier Device Package	896-FBGA (31x31)
Purchase URL	https://www.e-xfl.com/product-detail/microchip-technology/ax2000-1fgg896i

1 – General Description

Axcelerator devices offer high performance at densities of up to two million equivalent system gates. Based upon the Microsemi AX architecture, Axcelerator has several system-level features such as embedded SRAM (with complete FIFO control logic), PLLs, segmentable clocks, chip-wide highway routing, and carry logic.

Device Architecture

AX architecture, derived from the highly-successful SX-A sea-of-modules architecture, has been designed for high performance and total logic module utilization (Figure 1-1). Unlike in traditional FPGAs, the entire floor of the Axcelerator device is covered with a grid of logic modules, with virtually no chip area lost to interconnect elements or routing.

Programmable Interconnect Element

The Axcelerator family uses a patented metal-to-metal antifuse programmable interconnect element that resides between the upper two layers of metal (Figure 1-2 on page 1-2). This completely eliminates the channels of routing and interconnect resources between logic modules (as implemented on traditional FPGAs) and enables the efficient sea-of-modules architecture. The antifuses are normally open circuit and, when programmed, form a permanent, passive, low-impedance connection, leading to the fastest signal propagation in the industry. In addition, the extremely small size of these interconnect elements gives the Axcelerator family abundant routing resources.

The very nature of Microsemi's nonvolatile antifuse technology provides excellent protection against design pirating and cloning (FuseLock technology). Typical cloning attempts are impossible (even if the security fuse is left unprogrammed) as no bitstream or programming file is ever downloaded or stored in the device. Reverse engineering is virtually impossible due to the difficulty of trying to distinguish between programmed and unprogrammed antifuses and also due to the programming methodology of antifuse devices (see "Security" on page 2-108).

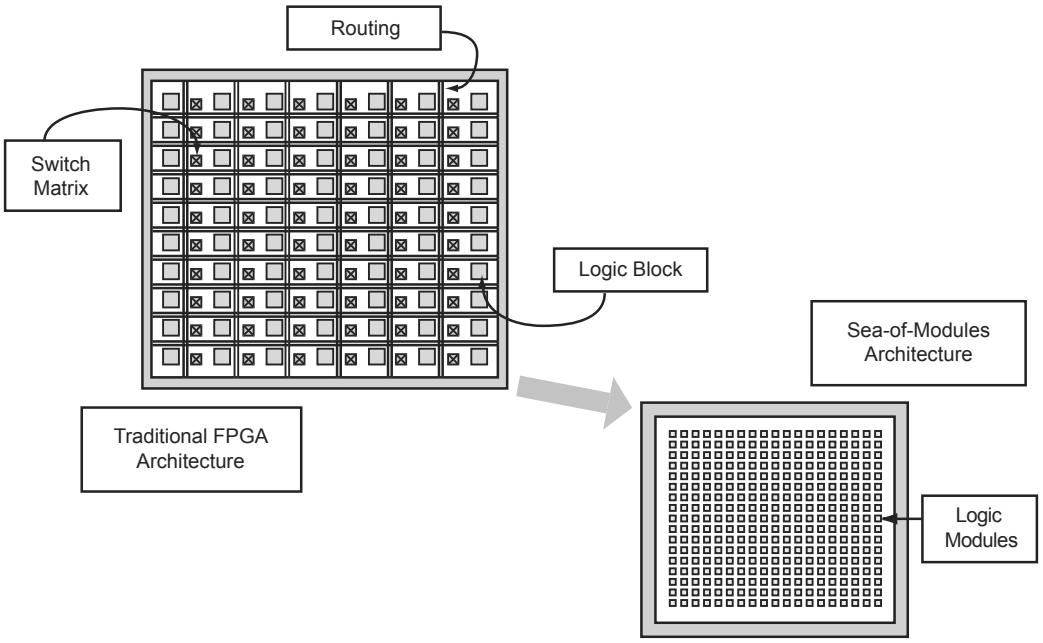


Figure 1-1 • **Sea-of-Modules Comparison**

The SRAM blocks are arranged in a column on the west side of the tile (Figure 1-6 on page 1-4).

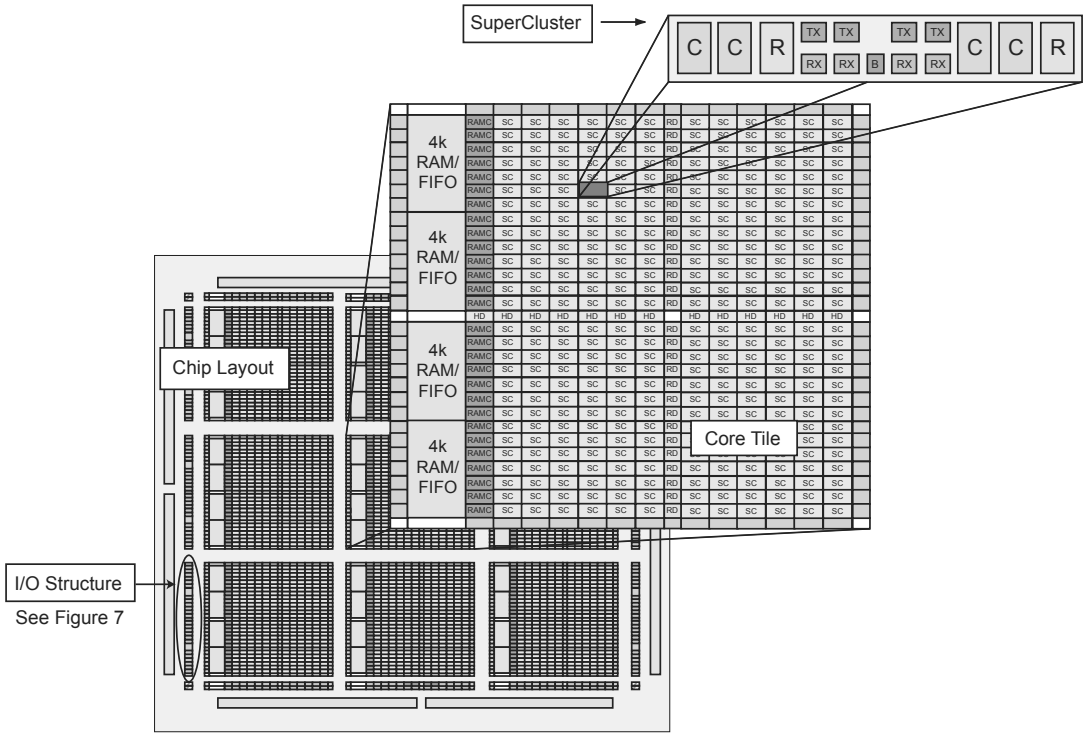


Figure 1-6 • **AX Device Architecture (AX1000 shown)**

Embedded Memory

As mentioned earlier, each core tile has either three (in a smaller tile) or four (in the regular tile) embedded SRAM blocks along the west side, and each variable-aspect-ratio SRAM block is 4,608 bits in size. Available memory configurations are: 128x36, 256x18, 512x9, 1kx4, 2kx2 or 4kx1 bits. The individual blocks have separate read and write ports that can be configured with different bit widths on each port. For example, data can be written in by eight and read out by one.

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 core logic modules. 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. In addition to the flag logic, the embedded FIFO control unit also contains the counters necessary for the generation of the read and write address pointers as well as control circuitry to prevent metastability and erroneous operation. The embedded SRAM/FIFO blocks can be cascaded to create larger configurations.

I/O Logic

The Axcelerator family of FPGAs features a flexible I/O structure, supporting a range of mixed voltages with its bank-selectable I/Os: 1.5V, 1.8V, 2.5V, and 3.3V. In all, Axcelerator FPGAs support at least 14 different I/O standards (single-ended, differential, voltage-referenced). The I/Os are organized into banks, with eight banks per device (two per side). The configuration of these banks determines the I/O standards supported (see "User I/Os" on page 2-11 for more information). All I/O standards are available in each bank.

Each I/O module has an input register (InReg), an output register (OutReg), and an enable register (EnReg) (Figure 1-7 on page 1-5). An I/O Cluster includes two I/O modules, four RX modules, two TX modules, and a buffer (B) module.

Timing Characteristics

***Table 2-35* • 3.3 V PCI I/O Module**
Worst-Case Commercial Conditions VCCA = 1.425 V, VCCI = 3.0 V, T_J = 70°C

		–2 Speed		–1 Speed		Std Speed		
Parameter	**Description**	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**	**Units**
3.3 V PCI Output Module Timing								
t_{DP}	Input Buffer		1.57		1.79		2.10	ns
t_{PY}	Output Buffer		1.91		2.18		2.56	ns
t_{ENZL}	Enable to Pad Delay through the Output Buffer—Z to Low		1.61		1.62		1.63	ns
t_{ENZH}	Enable to Pad Delay through the Output Buffer—Z to High		1.45		1.47		1.47	ns
t_{ENLZ}	Enable to Pad Delay through the Output Buffer—Low to Z		2.55		2.90		3.41	ns
t_{ENHZ}	Enable to Pad Delay through the Output Buffer—High to Z		3.52		4.01		4.72	ns
t_{IOCLKQ}	Sequential Clock-to-Q for the I/O Input Register		0.67		0.77		0.90	ns
t_{IOCLKY}	Clock-to-output Y for the I/O Output Register and the I/O Enable Register		0.67		0.77		0.90	ns
t_{SUD}	Data Input Set-Up		0.23		0.27		0.31	ns
t_{SUE}	Enable Input Set-Up		0.26		0.30		0.35	ns
t_{HD}	Data Input Hold		0.00		0.00		0.00	ns
t_{HE}	Enable Input Hold		0.00		0.00		0.00	ns
t_{CPWHL}	Clock Pulse Width High to Low	0.39		0.39		0.39		ns
t_{CPWLH}	Clock Pulse Width Low to High	0.39		0.39		0.39		ns
t_{WASYN}	Asynchronous Pulse Width	0.37		0.37		0.37		ns
t_{REASYN}	Asynchronous Recovery Time		0.13		0.15		0.17	ns
t_{HASYN}	Asynchronous Removal Time		0.00		0.00		0.00	ns
t_{CLR}	Asynchronous Clear-to-Q		0.23		0.27		0.31	
t_{PRESET}	Asynchronous Preset-to-Q		0.23		0.27		0.31	ns

Buffer Module

Introduction

An additional resource inside each SuperCluster is the Buffer (B) module (Figure 1-4 on page 1-3). When a fanout constraint is applied to a design, the synthesis tool inserts buffers as needed. The buffer module has been added to the AX architecture to avoid logic duplication resulting from the hard fanout constraints. The router utilizes this logic resource to save area and reduce loading and delays on medium-to-high-fanout nets.

Timing Models and Waveforms

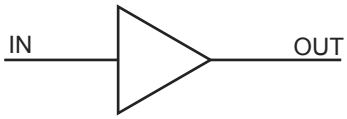


Figure 2-33 • **Buffer Module Timing Model**

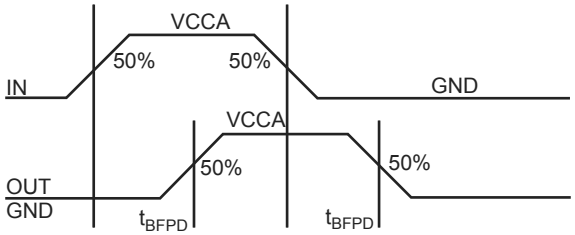


Figure 2-34 • **Buffer Module Waveform**

Timing Characteristics

Table 2-64 • **Buffer Module**
Worst-Case Commercial Conditions VCCA = 1.425 V, VCCI = 3.0 V, T_J = 70°C

		–2 Speed		–1 Speed		Std Speed		
Parameter	**Description**	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**	**Units**
Buffer Module Propagation Delays								
t_{BFPD}	Any input to output Y		0.12		0.14		0.16	ns

***Table 2-67* • AX500 Predicted Routing Delays**
Worst-Case Commercial Conditions VCCA = 1.425 V, T_J = 70°C

		–2 Speed	–1 Speed	Std Speed	
Parameter	**Description**	**Typical**	**Typical**	**Typical**	**Units**
Predicted Routing Delays					
t_{DC}	DirectConnect Routing Delay, FO1	0.11	0.12	0.15	ns
t_{FC}	FastConnect Routing Delay, FO1	0.35	0.39	0.46	ns
t_{RD1}	Routing delay for FO1	0.39	0.45	0.53	ns
t_{RD2}	Routing delay for FO2	0.41	0.46	0.54	ns
t_{RD3}	Routing delay for FO3	0.48	0.55	0.64	ns
t_{RD4}	Routing delay for FO4	0.56	0.63	0.75	ns
t_{RD5}	Routing delay for FO5	0.60	0.68	0.80	ns
t_{RD6}	Routing delay for FO6	0.84	0.96	1.13	ns
t_{RD7}	Routing delay for FO7	0.90	1.02	1.20	ns
t_{RD8}	Routing delay for FO8	1.00	1.13	1.33	ns
t_{RD16}	Routing delay for FO16	2.17	2.46	2.89	ns
t_{RD32}	Routing delay for FO32	3.55	4.03	4.74	ns

***Table 2-68* • AX1000 Predicted Routing Delays**
Worst-Case Commercial Conditions VCCA = 1.425 V, T_J = 70°C

		–2 Speed	–1 Speed	Std Speed	
Parameter	**Description**	**Typical**	**Typical**	**Typical**	**Units**
Predicted Routing Delays					
t_{DC}	DirectConnect Routing Delay, FO1	0.12	0.13	0.15	ns
t_{FC}	FastConnect Routing Delay, FO1	0.35	0.39	0.46	ns
t_{RD1}	Routing delay for FO1	0.45	0.51	0.60	ns
t_{RD2}	Routing delay for FO2	0.53	0.60	0.71	ns
t_{RD3}	Routing delay for FO3	0.56	0.63	0.74	ns
t_{RD4}	Routing delay for FO4	0.63	0.71	0.84	ns
t_{RD5}	Routing delay for FO5	0.73	0.82	0.97	ns
t_{RD6}	Routing delay for FO6	0.99	1.13	1.32	ns
t_{RD7}	Routing delay for FO7	1.02	1.15	1.36	ns
t_{RD8}	Routing delay for FO8	1.48	1.68	1.97	ns
t_{RD16}	Routing delay for FO16	2.57	2.91	3.42	ns
t_{RD32}	Routing delay for FO32	4.24	4.81	5.65	ns

***Table 2-102* • Sixteen FIFO Blocks Cascaded**
Worst-Case Commercial Conditions VCCA = 1.425 V, VCCI = 3.0 V, T_J = 70°C

		–2 Speed		–1 Speed		Std Speed		
Parameter	**Description**	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**	**Units**
FIFO Module Timing								
t_{WSU}	Write Setup		16.32		18.60		21.86	ns
t_{WHD}	Write Hold		0.00		0.00		0.00	ns
t_{WCKH}	WCLK High		0.75		0.75		0.75	ns
t_{WCKL}	WCLK Low		13.40		13.40		13.40	ns
t_{WCKP}	Minimum WCLK Period	14.15		14.15		14.15		ns
t_{RSU}	Read Setup		17.16		19.54		22.97	ns
t_{RHD}	Read Hold		0.00		0.00		0.00	ns
t_{RCKH}	RCLK High		0.73		0.73		0.73	ns
t_{RCKL}	RCLK Low		14.41		14.41		14.41	ns
t_{RCKP}	Minimum RCLK period	15.14		15.14		15.14		ns
t_{CLRHF}	Clear High		0.00		0.00		0.00	ns
t_{CLR2FF}	Clear-to-flag (EMPTY/FULL)		1.92		2.18		2.57	ns
t_{CLR2AF}	Clear-to-flag (AEMPTY/AFULL)		4.39		5.00		5.88	ns
t_{CK2FF}	Clock-to-flag (EMPTY/FULL)		2.13		2.42		2.85	ns
t_{CK2AF}	Clock-to-flag (AEMPTY/AFULL)		5.04		5.75		6.75	ns
$t_{RCK2RD1}$	RCLK-To-OUT (Pipelined)		12.08		13.76		16.17	ns
$t_{RCK2RD2}$	RCLK-To-OUT (Nonpipelined)		12.83		14.62		17.18	ns

Note: Timing data for these sixteen cascaded FIFO blocks uses a depth of 65,536. For all other combinations, use Microsemi's timing software.

Building RAM and FIFO Modules

RAM and FIFO modules can be generated and included in a design in two different ways:

- Using the SmartGen Core Generator where the user defines the depth and width of the FIFO/RAM, and then instantiates this block into the design (refer to the *SmartGen, FlashROM, Analog System Builder, and Flash Memory System Builder* User's Guide for more information).
- The alternative is to instantiate the RAM/FIFO blocks manually, using inverters for polarity control and tying all unused data bits to ground.

Other Architectural Features

Low Power Mode

Although designed for high performance, the AX architecture also allows the user to place the device into a low power mode. Each I/O bank in an Axcelerator device can be configured individually, when in low power mode, to tristate all outputs, disable inputs, or both. The low power mode is activated by asserting the LP pin, which is grounded in normal operation.

While in the low power mode, the device is still fully functional and all internal logic states are preserved. This allows a user to disable all but a few signals and operate the part in a low-frequency, watchdog

BG729	
AX1000 Function	Pin Number
Bank 0	
IO00NB0F0	E6
IO00PB0F0	F6
IO01NB0F0	G8
IO01PB0F0	G7
IO02NB0F0	D7
IO02PB0F0	E7
IO03NB0F0	D5
IO03PB0F0	E5
IO04NB0F0	G9
IO04PB0F0	H9
IO05NB0F0	E8
IO05PB0F0	F8
IO06NB0F0	C6
IO06PB0F0	D6
IO07NB0F0	B5
IO07PB0F0	C5
IO08NB0F0	A6
IO08PB0F0	A5
IO09NB0F0	E9
IO09PB0F0	F9
IO10NB0F0	G10
IO10PB0F0	H10
IO11NB0F0	B7
IO11PB0F0	B6
IO12NB0F1	C8
IO12PB0F1	C7
IO13NB0F1	E10
IO13PB0F1	F10
IO14NB0F1	G11
IO14PB0F1	H11
IO15NB0F1	D9
IO15PB0F1	D8
IO16NB0F1	A8
IO16PB0F1	A7
IO17NB0F1	B9
IO17PB0F1	B8

BG729	
AX1000 Function	Pin Number
IO18NB0F1	C10
IO18PB0F1	C9
IO19NB0F1	E11
IO19PB0F1	F11
IO20NB0F1	G12
IO20PB0F1	H12
IO21NB0F1	D11
IO21PB0F1	D10
IO22NB0F2	A10
IO22PB0F2	A9
IO23NB0F2	B11
IO23PB0F2	B10
IO24NB0F2	G13
IO24PB0F2	H13
IO25NB0F2	C12
IO25PB0F2	C11
IO26NB0F2	E12
IO26PB0F2	D12
IO27NB0F2	E13
IO27PB0F2	F13
IO28NB0F2	G14
IO28PB0F2	H14
IO29NB0F2	A12
IO29PB0F2	B12
IO30NB0F2/HCLKAN	C13
IO30PB0F2/HCLKAP	D13
IO31NB0F2/HCLKBN	F14
IO31PB0F2/HCLKBP	E14
Bank 1	
IO32NB1F3/HCLKCN	C14
IO32PB1F3/HCLKCP	B14
IO33NB1F3/HCLKDN	D16
IO33PB1F3/HCLKDP	D15
IO34NB1F3	B16
IO34PB1F3	A16
IO35NB1F3	E15
IO35PB1F3	F15

BG729	
AX1000 Function	Pin Number
IO36NB1F3	H15
IO36PB1F3	G15
IO37NB1F3	C17
IO37PB1F3	C16
IO38NB1F3	B18
IO38PB1F3	B17
IO39NB1F3	A18
IO39PB1F3	A17
IO40NB1F3	H16
IO40PB1F3	G16
IO41NB1F4	B19
IO41PB1F4	A19
IO42NB1F4	C19
IO42PB1F4	C18
IO43NB1F4	D18
IO43PB1F4	D17
IO44NB1F4	H17
IO44PB1F4	G17
IO45NB1F4	F17
IO45PB1F4	E17
IO46NB1F4	B20
IO46PB1F4	A20
IO47NB1F4	C21
IO47PB1F4	C20
IO48NB1F4	H18
IO48PB1F4	G18
IO49NB1F4	F18
IO49PB1F4	E18
IO50NB1F4	D20
IO50PB1F4	D19
IO51NB1F4	A22
IO51PB1F4	A21
IO52NB1F4	B22
IO52PB1F4	B21
IO53NB1F4	F19
IO53PB1F4	E19
IO54NB1F5	F20

FG484	
AX250 Function	**Pin Number**
IO52NB3F3	P18
IO52PB3F3	P19
IO53NB3F3	R20
IO53PB3F3	P20
IO54NB3F3	T21
IO54PB3F3	R21
IO55NB3F3	R17
IO55PB3F3	P17
IO56NB3F3	U20
IO56PB3F3	T20
IO57NB3F3	T18
IO57PB3F3	R18
IO58NB3F3	U19
IO58PB3F3	T19
IO59NB3F3	R16
IO59PB3F3	P16
IO60NB3F3	W20
IO60PB3F3	V20
IO61NB3F3	U18
IO61PB3F3	V19
Bank 4	
IO62NB4F4	T15
IO62PB4F4	T16
IO63NB4F4	W17
IO63PB4F4	V17
IO64NB4F4	V15
IO64PB4F4	V16
IO65NB4F4	Y19
IO65PB4F4	W18
IO66NB4F4	AB18
IO66PB4F4	AB19
IO67NB4F4	W15
IO67PB4F4	W16
IO68NB4F4	U14
IO68PB4F4	U15
IO69NB4F4	AA16

FG484	
AX250 Function	**Pin Number**
IO69PB4F4	AA17
IO70NB4F4	AB14
IO70PB4F4	AB15
IO71NB4F4	Y14
IO71PB4F4	W14
IO72NB4F4	AA14
IO72PB4F4	AA15
IO73NB4F4	AA13
IO73PB4F4	AB13
IO74NB4F4/CLKEN	V12
IO74PB4F4/CLKEP	V13
IO75NB4F4/CLKFN	W11
IO75PB4F4/CLKFP	W12
Bank 5	
IO76NB5F5/CLKGN	U10
IO76PB5F5/CLKGP	U11
IO77NB5F5/CLKHN	V9
IO77PB5F5/CLKHP	V10
IO78NB5F5	AA9
IO78PB5F5	AA10
IO79NB5F5	AB9
IO79PB5F5	AB10
IO80NB5F5	AA7
IO80PB5F5	AA8
IO81NB5F5	W8
IO81PB5F5	W9
IO82NB5F5	AB5
IO82PB5F5	AB6
IO83NB5F5	AA5
IO83PB5F5	AA6
IO84NB5F5	U8
IO84PB5F5	U9
IO85NB5F5	Y6
IO85PB5F5	Y7
IO86NB5F5	W6
IO86PB5F5	W7

FG484	
AX250 Function	**Pin Number**
IO87NB5F5	Y4
IO87PB5F5	Y5
IO88NB5F5	V6
IO88PB5F5	V7
IO89NB5F5	T7
IO89PB5F5	T8
Bank 6	
IO90NB6F6	V4
IO90PB6F6	W5
IO91NB6F6	P7
IO91PB6F6	R7
IO92NB6F6	U5
IO92PB6F6	T5
IO93NB6F6	P6
IO93PB6F6	R6
IO94NB6F6	T4
IO94PB6F6	U4
IO95NB6F6	P5
IO95PB6F6	R5
IO96NB6F6	T3
IO96PB6F6	U3
IO97NB6F6	P3
IO97PB6F6	R3
IO98NB6F6	R2
IO98PB6F6	T2
IO99NB6F6	P4
IO99PB6F6	R4
IO100NB6F6	P1
IO100PB6F6	R1
IO101NB6F6	M7
IO101PB6F6	N7
IO102NB6F6	N2
IO102PB6F6	P2
IO103NB6F6	M6
IO103PB6F6	N6
IO104NB6F6	M4

FG676	
AX500 Function	Pin Number
Bank 0	
IO00NB0F0	F8
IO00PB0F0	E8
IO01NB0F0	A5
IO01PB0F0	A4
IO02NB0F0	E7
IO02PB0F0	E6
IO03NB0F0	D6
IO03PB0F0	D5
IO04NB0F0	B5
IO04PB0F0	C5
IO05NB0F0	B6
IO05PB0F0	C6
IO06NB0F0	C7
IO06PB0F0	D7
IO07NB0F0	A7
IO07PB0F0	A6
IO08NB0F0	C8
IO08PB0F0	D8
IO09NB0F0	F10
IO09PB0F0	F9
IO10NB0F0	B8
IO10PB0F0	B7
IO11NB0F0	D10
IO11PB0F0	E10
IO12NB0F1	B9
IO12PB0F1	C9
IO13NB0F1	F11
IO13PB0F1	G11
IO14NB0F1	D11
IO14PB0F1	E11
IO15NB0F1	B10
IO15PB0F1	C10
IO16NB0F1	A10
IO16PB0F1	A9

FG676	
AX500 Function	Pin Number
IO17NB0F1	F12
IO17PB0F1	G12
IO18NB0F1	C12
IO18PB0F1	C11
IO19NB0F1/HCLKAN	A12
IO19PB0F1/HCLKAP	B12
IO20NB0F1/HCLKBN	C13
IO20PB0F1/HCLKBP	B13
Bank 1	
IO21NB1F2/HCLKCN	C15
IO21PB1F2/HCLKCP	C14
IO22NB1F2/HCLKDN	A15
IO22PB1F2/HCLKDP	B15
IO23NB1F2	F15
IO23PB1F2	G15
IO24NB1F2	B16
IO24PB1F2	A16
IO25NB1F2	A18
IO25PB1F2	A17
IO26NB1F2	D16
IO26PB1F2	E16
IO27NB1F2	F16
IO27PB1F2	G16
IO28NB1F2	C18
IO28PB1F2	C17
IO29NB1F2	B19
IO29PB1F2	B18
IO30NB1F2	D19
IO30PB1F2	C19
IO31NB1F2	F17
IO31PB1F2	E17
IO32NB1F3	B20
IO32PB1F3	A20
IO33NB1F3	B22
IO33PB1F3	B21

FG676	
AX500 Function	Pin Number
IO34NB1F3	D20
IO34PB1F3	C20
IO35NB1F3	D21
IO35PB1F3	C21
IO36NB1F3	D22
IO36PB1F3	C22
IO37NB1F3	F19
IO37PB1F3	E19
IO38NB1F3	B23
IO38PB1F3	A23
IO39NB1F3	E21
IO39PB1F3	E20
IO40NB1F3	D23
IO40PB1F3	C23
IO41NB1F3	D25
IO41PB1F3	C25
Bank 2	
IO42NB2F4	G24
IO42PB2F4	G23
IO43NB2F4	G26
IO43PB2F4	F26
IO44NB2F4	F25
IO44PB2F4	E25
IO45NB2F4	J21
IO45PB2F4	J22
IO46NB2F4	H25
IO46PB2F4	G25
IO47NB2F4	K23
IO47PB2F4	J23
IO48NB2F4	J24
IO48PB2F4	H24
IO49NB2F4	K21
IO49PB2F4	K22
IO50NB2F4	K25
IO50PB2F4	J25

FG896	
AX1000 Function	Pin Number
IO103NB3F9	V27
IO103PB3F9	U27
IO104NB3F9	W29
IO104PB3F9	V29
IO105NB3F9	Y28
IO105PB3F9	W28
IO106NB3F9	V25
IO106PB3F9	U25
IO107NB3F10	W26
IO107PB3F10	V26
IO108NB3F10	W24
IO108PB3F10	V24
IO109NB3F10	Y27
IO109PB3F10	W27
IO110NB3F10	V23
IO110PB3F10	V22
IO111NB3F10	AA29
IO111PB3F10	Y29
IO112NB3F10	Y25
IO112PB3F10	W25
IO113NB3F10	AB27
IO113PB3F10	AA27
IO114NB3F10	Y23
IO114PB3F10	W23
IO115NB3F10	AA26
IO115PB3F10	Y26
IO116NB3F10	AC28
IO116PB3F10	AB28
IO117NB3F10	AE29
IO117PB3F10	AD29
IO118NB3F11	AE28
IO118PB3F11	AD28
IO119NB3F11	AD27
IO119PB3F11	AC27
IO120NB3F11	AA24

FG896	
AX1000 Function	Pin Number
IO120PB3F11	Y24
IO121NB3F11	AB25
IO121PB3F11	AA25
IO122NB3F11	AC26
IO122PB3F11	AB26
IO123NB3F11	AG28
IO123PB3F11	AF28
IO124NB3F11	AB23
IO124PB3F11	AA23
IO125NB3F11	AF27
IO125PB3F11	AE27
IO126NB3F11	AD25
IO126PB3F11	AC25
IO127NB3F11	AE26
IO127PB3F11	AD26
IO128NB3F11	AC24
IO128PB3F11	AB24
Bank 4	
IO129NB4F12	AD23
IO129PB4F12	AC23
IO130NB4F12	AK26
IO130PB4F12	AK27
IO131NB4F12	AF24
IO131PB4F12	AF25
IO132NB4F12	AG25
IO132PB4F12	AG26
IO133NB4F12	AD22
IO133PB4F12	AC22
IO134NB4F12	AE23
IO134PB4F12	AE24
IO135NB4F12	AH24
IO135PB4F12	AH25
IO136NB4F12	AJ25
IO136PB4F12	AJ26
IO137NB4F12	AD21

FG896	
AX1000 Function	Pin Number
IO137PB4F12	AC21
IO138NB4F12	AK24
IO138PB4F12	AK25
IO139NB4F13	AE21
IO139PB4F13	AE22
IO140NB4F13	AG23
IO140PB4F13	AG24
IO141NB4F13	AF22
IO141PB4F13	AF23
IO142NB4F13	AJ23
IO142PB4F13	AJ24
IO143NB4F13	AD19
IO143PB4F13	AD20
IO144NB4F13	AG21
IO144PB4F13	AG22
IO145NB4F13	AE19
IO145PB4F13	AE20
IO146NB4F13	AF20
IO146PB4F13	AF21
IO147NB4F13	AC19
IO147PB4F13	AC20
IO148NB4F13	AH22
IO148PB4F13	AH23
IO149NB4F13	AC18
IO149PB4F13	AB18
IO150NB4F13	AK21
IO150PB4F13	AJ21
IO151NB4F13	AE18
IO151PB4F13	AD18
IO152NB4F14	AJ20
IO152PB4F14	AK20
IO153NB4F14	AG19
IO153PB4F14	AG20
IO154NB4F14	AH19
IO154PB4F14	AH20

FG896	
AX1000 Function	Pin Number
NC	K1
NC	K2
NC	L30
NC	M30
NC	N29
NC	T1
NC	U1
NC	W30
NC	Y1
NC	Y2
NC	Y30
PRA	G15
PRB	D16
PRC	AB16
PRD	AF16
TCK	G7
TDI	D5
TDO	J8
TMS	F6
TRST	C4
VCCA	AD6
VCCA	AH26
VCCA	E28
VCCA	E3
VCCA	L12
VCCA	L13
VCCA	L14
VCCA	L15
VCCA	L16
VCCA	L17
VCCA	L18
VCCA	L19
VCCA	M11
VCCA	M20
VCCA	N11

FG896	
AX1000 Function	Pin Number
VCCA	N20
VCCA	P11
VCCA	P20
VCCA	R11
VCCA	R20
VCCA	T11
VCCA	T20
VCCA	U11
VCCA	U20
VCCA	V11
VCCA	V20
VCCA	W11
VCCA	W20
VCCA	Y12
VCCA	Y13
VCCA	Y14
VCCA	Y15
VCCA	Y16
VCCA	Y17
VCCA	Y18
VCCA	Y19
VCCPLA	G14
VCCPLB	H15
VCCPLC	G17
VCCPLD	J16
VCCPLE	AH17
VCCPLF	AC16
VCCPLG	AH14
VCCPLH	AD15
VCCDA	AD24
VCCDA	AD7
VCCDA	AF12
VCCDA	AF13
VCCDA	AF15
VCCDA	AF18

FG896	
AX1000 Function	Pin Number
VCCDA	AF19
VCCDA	C13
VCCDA	C5
VCCDA	D13
VCCDA	D19
VCCDA	D3
VCCDA	E18
VCCDA	F26
VCCDA	G16
VCCDA	T25
VCCDA	T4
VCCIB0	A3
VCCIB0	B3
VCCIB0	J10
VCCIB0	J11
VCCIB0	J12
VCCIB0	K11
VCCIB0	K12
VCCIB0	K13
VCCIB0	K14
VCCIB0	K15
VCCIB1	A28
VCCIB1	B28
VCCIB1	J19
VCCIB1	J20
VCCIB1	J21
VCCIB1	K16
VCCIB1	K17
VCCIB1	K18
VCCIB1	K19
VCCIB1	K20
VCCIB2	C29
VCCIB2	C30
VCCIB2	K22
VCCIB2	L21

FG896	
AX2000 Function	Pin Number
IO124NB2F11	P29
IO124PB2F11	P30
IO125NB2F11	R22
IO125PB2F11	R23
IO127NB2F11	R24
IO127PB2F11	R25
IO128NB2F11	R29
IO128PB2F11	R30
Bank 3	
IO129NB3F12	T27
IO129PB3F12	R27
IO130NB3F12	T29
IO130PB3F12	T30
IO131NB3F12	T22
IO131PB3F12	T23
IO132NB3F12	U26
IO132PB3F12	T26
IO133NB3F12	U24
IO133PB3F12	T24
IO135NB3F12	U23
IO135PB3F12	U22
IO136NB3F12	U29
IO136PB3F12	U30
IO137NB3F12	V28
IO137PB3F12	U28
IO138NB3F12	V27
IO138PB3F12	U27
IO139NB3F13	V25
IO139PB3F13	U25
IO141NB3F13	V23
IO141PB3F13	V22
IO142NB3F13	W29
IO142PB3F13	V29
IO143NB3F13	W26
IO143PB3F13	V26

FG896	
AX2000 Function	Pin Number
IO145NB3F13	W24
IO145PB3F13	V24
IO146NB3F13	W27
IO146PB3F13	W28
IO147NB3F13	Y28
IO147PB3F13	Y27
IO148NB3F13	Y30
IO148PB3F13	W30
IO149NB3F13	Y25
IO149PB3F13	W25
IO150NB3F14	AA29
IO150PB3F14	Y29
IO151NB3F14	AC29
IO152NB3F14	AA26
IO152PB3F14	Y26
IO153NB3F14	Y23
IO153PB3F14	W23
IO154NB3F14	AB30
IO154PB3F14	AA30
IO155NB3F14	AB27
IO155PB3F14	AA27
IO156NB3F14	AC28
IO156PB3F14	AB28
IO157NB3F14	AA24
IO157PB3F14	Y24
IO158NB3F14	AF29
IO158PB3F14	AF30
IO159NB3F14	AB25
IO159PB3F14	AA25
IO160NB3F14	AE30
IO160PB3F14	AD30
IO161NB3F15	AE29
IO161PB3F15	AD29
IO162NB3F15	AD27
IO162PB3F15	AC27

FG896	
AX2000 Function	Pin Number
IO163NB3F15	AC26
IO163PB3F15	AB26
IO164NB3F15	AE28
IO164PB3F15	AD28
IO165NB3F15	AC24
IO165PB3F15	AB24
IO166NB3F15	AG28
IO166PB3F15	AF28
IO167NB3F15	AE26
IO167PB3F15	AD26
IO168NB3F15	AD25
IO168PB3F15	AC25
IO169NB3F15	AF27
IO169PB3F15	AE27
IO170NB3F15	AB23
IO170PB3F15	AA23
Bank 4	
IO171NB4F16	AG29
IO171PB4F16	AG30
IO172NB4F16	AF24
IO172PB4F16	AF25
IO173NB4F16	AG25
IO173PB4F16	AG26
IO174NB4F16	AJ25
IO174PB4F16	AJ26
IO175NB4F16	AK26
IO175PB4F16	AK27
IO176NB4F16	AE23
IO176PB4F16	AE24
IO177NB4F16	AH24
IO177PB4F16	AH25
IO178NB4F16	AD23
IO178PB4F16	AC23
IO179PB4F16	AJ27
IO180NB4F16	AG23

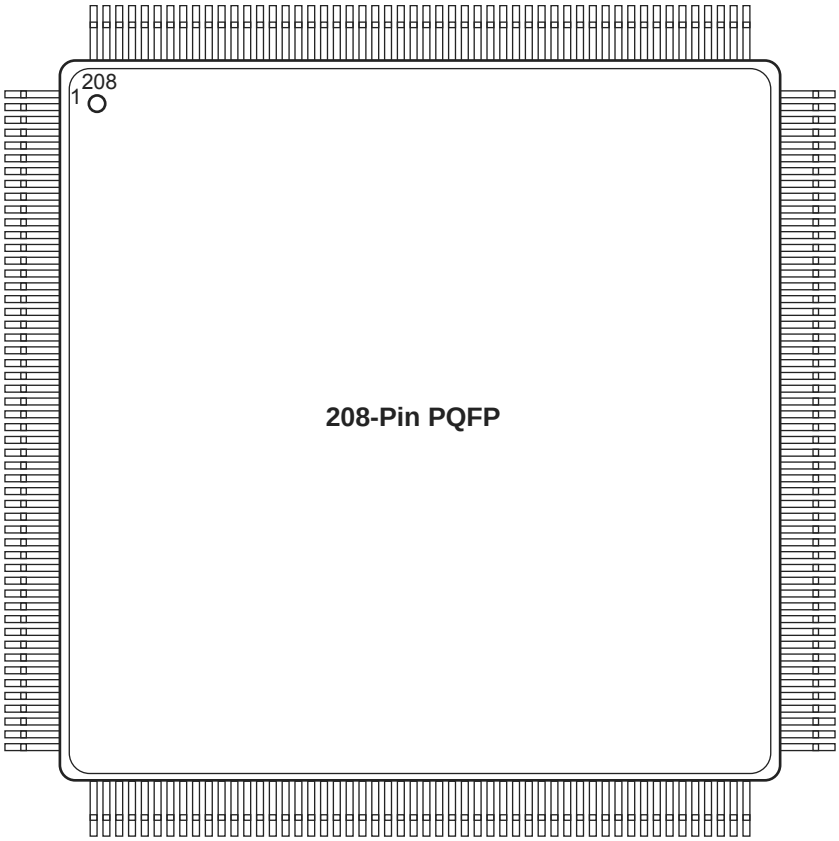
FG896	
AX2000 Function	**Pin Number**
IO303PB7F28	R1
IO304NB7F28	R7
IO304PB7F28	R6
IO306NB7F28	N2
IO306PB7F28	P2
IO307NB7F28	N3
IO307PB7F28	P3
IO308NB7F28	P9
IO308PB7F28	P8
IO309NB7F28	P4
IO309PB7F28	P5
IO310NB7F29	P7
IO310PB7F29	P6
IO311NB7F29	L1
IO311PB7F29	M1
IO312NB7F29	M5
IO312PB7F29	N5
IO313NB7F29	M4
IO313PB7F29	N4
IO315NB7F29	L2
IO315PB7F29	M2
IO316NB7F29	N7
IO316PB7F29	N6
IO317NB7F29	L3
IO317PB7F29	M3
IO318NB7F29	N8
IO318PB7F29	N9
IO320NB7F29	L6
IO320PB7F29	M6
IO321NB7F30	K4
IO321PB7F30	L4
IO322NB7F30	M8
IO322PB7F30	M7
IO323NB7F30	J1
IO323PB7F30	K1

FG896	
AX2000 Function	**Pin Number**
IO324NB7F30	K5
IO324PB7F30	L5
IO326NB7F30	G1*
IO326PB7F30	K2*
IO327NB7F30	J4
IO327PB7F30	J3
IO328NB7F30	L8
IO328PB7F30	L7
IO329NB7F30	G2
IO329PB7F30	H2
IO330NB7F30	G3
IO330PB7F30	H3
IO331NB7F30	K8
IO331PB7F30	K7
IO332NB7F31	J6
IO332PB7F31	K6
IO333NB7F31	D1
IO333PB7F31	D2
IO334NB7F31	G4
IO334PB7F31	H4
IO335NB7F31	F2
IO335PB7F31	F1
IO336NB7F31	H5
IO336PB7F31	J5
IO337NB7F31	E2
IO337PB7F31	E1
IO338NB7F31	H7
IO338PB7F31	J7
IO339NB7F31	F4
IO339PB7F31	F3
IO340NB7F31	F5
IO340PB7F31	G5
IO341NB7F31	G6
IO341PB7F31	H6
Dedicated I/O	

FG896	
AX2000 Function	**Pin Number**
GND	A13
GND	A18
GND	A2
GND	A23
GND	A29
GND	A8
GND	AA10
GND	AA21
GND	AA28
GND	AA3
GND	AB2
GND	AB22
GND	AB29
GND	AB9
GND	AC1
GND	AC30
GND	AE25
GND	AE6
GND	AF26
GND	AF5
GND	AG27
GND	AG4
GND	AH10
GND	AH15
GND	AH16
GND	AH21
GND	AH28
GND	AH3
GND	AJ1
GND	AJ2
GND	AJ22
GND	AJ29
GND	AJ30
GND	AJ9
GND	AK13

FG1152	
AX2000 Function	**Pin Number**
VCOMPLD	K18
VCOMPLE	AH19
VCOMPLF	AF18
VCOMPLG	AH16
VCOMPLH	AD17
VPUMP	J26

PQ208



Note

For Package Manufacturing and Environmental information, visit Resource center at http://www.microsemi.com/soc/products/rescenter/package/index.html.

CQ208	
AX500 Function	Pin Number
Bank 0	
IO03NB0F0	198
IO03PB0F0	199
IO04NB0F0	197
IO19NB0F1/HCLKAN	191
IO19PB0F1/HCLKAP	192
IO20NB0F1/HCLKBN	185
IO20PB0F1/HCLKBP	186
Bank 1	
IO21NB1F2/HCLKCN	180
IO21PB1F2/HCLKCP	181
IO22NB1F2/HCLKDN	174
IO22PB1F2/HCLKDP	175
IO23NB1F2	170
IO23PB1F2	171
IO37NB1F3	165
IO37PB1F3	166
IO39NB1F3	161
IO39PB1F3	162
IO41NB1F3	159
IO41PB1F3	160
Bank 2	
IO43NB2F4	151
IO43PB2F4	153
IO44NB2F4	152
IO44PB2F4	154
IO45PB2F4	148
IO46NB2F4	146
IO46PB2F4	147
IO48NB2F4	144
IO48PB2F4	145
IO57NB2F5	139
IO57PB2F5	140
IO58PB2F5	141
IO59NB2F5	137
IO59PB2F5	138
IO61NB2F5	132

CQ208	
AX500 Function	Pin Number
IO61PB2F5	134
IO62NB2F5	131
IO62PB2F5	133
Bank 3	
IO63NB3F6	127
IO63PB3F6	129
IO64NB3F6	126
IO64PB3F6	128
IO66NB3F6	122
IO66PB3F6	123
IO68NB3F6	120
IO68PB3F6	121
IO77NB3F7	116
IO77PB3F7	117
IO79NB3F7	114
IO79PB3F7	115
IO81NB3F7	110
IO81PB3F7	111
IO82NB3F7	108
IO82PB3F7	109
IO83NB3F7	106
IO83PB3F7	107
Bank 4	
IO84PB4F8	103
IO85NB4F8	100
IO86NB4F8	101
IO86PB4F8	102
IO87NB4F8	96
IO87PB4F8	97
IO101NB4F9	91
IO101PB4F9	92
IO103NB4F9/CLKEN	87
IO103PB4F9/CLKEP	88
IO104NB4F9/CLKFN	81
IO104PB4F9/CLKFP	82
Bank 5	
IO105NB5F10/CLKGN	76

CQ208	
AX500 Function	Pin Number
IO105PB5F10/CLKGP	77
IO106NB5F10/CLKHN	70
IO106PB5F10/CLKHP	71
IO107NB5F10	66
IO107PB5F10	67
IO119NB5F11	62
IO121NB5F11	60
IO121PB5F11	61
IO123NB5F11	56
IO123PB5F11	57
IO125NB5F11	54
IO125PB5F11	55
Bank 6	
IO127NB6F12	47
IO127PB6F12	49
IO128NB6F12	48
IO128PB6F12	50
IO129NB6F12	42
IO129PB6F12	43
IO130PB6F12	44
IO132NB6F12	40
IO132PB6F12	41
IO141NB6F13	35
IO141PB6F13	36
IO142PB6F13	37
IO143NB6F13	33
IO143PB6F13	34
IO145NB6F13	28
IO145PB6F13	30
IO146NB6F13	27
IO146PB6F13	29
Bank 7	
IO147NB7F14	23
IO147PB7F14	25
IO148NB7F14	22
IO148PB7F14	24
IO150NB7F14	18

CQ352	
AX2000 Function	Pin Number
GND	21
GND	27
GND	33
GND	39
GND	45
GND	51
GND	57
GND	63
GND	69
GND	75
GND	81
GND	88
GND	89
GND	97
GND	103
GND	109
GND	115
GND	121
GND	133
GND	145
GND	151
GND	157
GND	163
GND	169
GND	176
GND	177
GND	186
GND	192
GND	198
GND	204
GND	210
GND	216
GND	222
GND	228
GND	234

CQ352	
AX2000 Function	Pin Number
GND	240
GND	246
GND	252
GND	258
GND	264
GND	265
GND	274
GND	280
GND	286
GND	292
GND	298
GND	310
GND	322
GND	330
GND	334
GND	340
GND	345
GND	352
PRA	312
PRB	311
PRC	135
PRD	134
TCK	349
TDI	348
TDO	347
TMS	350
TRST	351
VCCA	3
VCCA	14
VCCA	32
VCCA	56
VCCA	74
VCCA	87
VCCA	102
VCCA	114

CQ352	
AX2000 Function	Pin Number
VCCA	150
VCCA	162
VCCA	175
VCCA	191
VCCA	209
VCCA	233
VCCA	251
VCCA	263
VCCA	279
VCCA	291
VCCA	329
VCCA	339
VCCDA	2
VCCDA	44
VCCDA	90
VCCDA	91
VCCDA	116
VCCDA	117
VCCDA	130
VCCDA	131
VCCDA	132
VCCDA	148
VCCDA	149
VCCDA	174
VCCDA	178
VCCDA	221
VCCDA	266
VCCDA	268
VCCDA	293
VCCDA	294
VCCDA	307
VCCDA	308
VCCDA	309
VCCDA	327
VCCDA	328

CG624	
AX1000 Function	**Pin Number**
IO63PB1F5	G18
Bank 2	
IO64NB2F6	M17
IO64PB2F6	G22
IO65NB2F6	J21
IO65PB2F6	J20
IO66NB2F6	L23
IO66PB2F6	K20
IO67NB2F6	F23
IO67PB2F6	E23
IO68NB2F6	L18
IO68PB2F6	K18
IO70NB2F6	E24
IO70PB2F6	D24
IO71NB2F6	H23
IO71PB2F6	G23
IO72NB2F6	L19
IO72PB2F6	K19
IO74NB2F7	J22
IO74PB2F7	H22
IO75NB2F7	N23
IO75PB2F7	M23
IO76NB2F7	N17
IO76PB2F7	N16
IO77NB2F7	L22
IO77PB2F7	K22
IO78NB2F7	M19
IO78PB2F7	M18
IO79NB2F7	N19
IO79PB2F7	N18
IO80NB2F7	L21
IO80PB2F7	L20
IO82NB2F7	P18
IO82PB2F7	P17
IO83NB2F7	N22
IO83PB2F7	M22

CG624	
AX1000 Function	**Pin Number**
IO84NB2F7	M20
IO84PB2F7	M21
IO86NB2F8	E25
IO86PB2F8	D25
IO87NB2F8	L24
IO87PB2F8	K24
IO88NB2F8	G24
IO88PB2F8	F24
IO89NB2F8	J25
IO90NB2F8	G25
IO90PB2F8	F25
IO91NB2F8	L25
IO91PB2F8	K25
IO92NB2F8	J24
IO92PB2F8	H24
IO93PB2F8	J23
IO94NB2F8	N24
IO94PB2F8	M24
IO95NB2F8	N25
IO95PB2F8	M25
Bank 3	
IO96NB3F9	T18
IO96PB3F9	R18
IO97NB3F9	N20
IO97PB3F9	P24
IO98NB3F9	P20
IO98PB3F9	P19
IO99NB3F9	P21
IO100NB3F9	T22
IO100PB3F9	W24
IO101NB3F9	R22
IO101PB3F9	P22
IO102NB3F9	U19
IO102PB3F9	T19
IO104NB3F9	V20
IO104PB3F9	U20

CG624	
AX1000 Function	**Pin Number**
IO105NB3F9	R23
IO105PB3F9	P23
IO106NB3F9	R19
IO106PB3F9	R20
IO107NB3F10	AB24
IO108NB3F10	R25
IO108PB3F10	P25
IO109NB3F10	U25
IO109PB3F10	T25
IO110NB3F10	U24
IO110PB3F10	U23
IO112NB3F10	T24
IO112PB3F10	R24
IO113NB3F10	Y25
IO113PB3F10	W25
IO114NB3F10	V23
IO114PB3F10	V24
IO116NB3F10	AA24
IO116PB3F10	Y24
IO117NB3F10	AB25
IO117PB3F10	AA25
IO118NB3F11	T20
IO118PB3F11	R21
IO120NB3F11	W22
IO120PB3F11	W23
IO122NB3F11	V22
IO122PB3F11	U22
IO124NB3F11	Y23
IO124PB3F11	AA23
IO126NB3F11	V21
IO126PB3F11	U21
IO128NB3F11	Y22
IO128PB3F11	Y21
Bank 4	
IO129NB4F12	W20
IO129PB4F12	Y20

CG624	
AX2000 Function	**Pin Number**
IO310NB7F29	N10
IO310PB7F29	N9
IO311NB7F29	K1
IO311PB7F29	L1
IO313NB7F29	M5
IO316NB7F29	L6
IO316PB7F29	L5
IO317NB7F29	K2
IO317PB7F29	L2
IO318NB7F29	K4
IO318PB7F29	L4
IO320NB7F29	J3
IO321NB7F30	J2
IO321PB7F30	J1
IO323NB7F30	L7
IO323PB7F30	M7
IO324NB7F30	M9
IO324PB7F30	M8
IO327NB7F30	F1
IO327PB7F30	G1
IO328NB7F30	K7
IO328PB7F30	K6
IO329NB7F30	D1
IO329PB7F30	E1
IO331PB7F30	G2
IO332NB7F31	H3
IO332PB7F31	H2
IO333NB7F31	E2
IO333PB7F31	F2
IO334NB7F31	H4
IO334PB7F31	J4
IO335NB7F31	H5

*Note: *Not routed on the same package layer and to adjacent LGA pads as its differential pair complement. Recommended to be used as a single-ended I/O.*

CG624	
AX2000 Function	**Pin Number**
IO335PB7F31	H6
IO337NB7F31	D2
IO338NB7F31	J6
IO338PB7F31	J5
IO339NB7F31	F3
IO339PB7F31	E3
IO340NB7F31	G4*
IO340PB7F31	G3*
IO341NB7F31	K8
IO341PB7F31	L8
Dedicated I/O	
GND	K5
GND	A18
GND	A2
GND	A24
GND	A25
GND	A8
GND	AA10
GND	AA16
GND	AA18
GND	AA21
GND	AA5
GND	AB22
GND	AB4
GND	AC10
GND	AC16
GND	AC23
GND	AC3
GND	AD1
GND	AD2
GND	AD24
GND	AD25

*Note: *Not routed on the same package layer and to adjacent LGA pads as its differential pair complement. Recommended to be used as a single-ended I/O.*

CG624	
AX2000 Function	**Pin Number**
GND	AE1
GND	AE18
GND	AE2
GND	AE24
GND	AE25
GND	AE8
GND	B1
GND	B2
GND	B24
GND	B25
GND	C10
GND	C16
GND	C23
GND	C3
GND	D22
GND	D4
GND	E10
GND	E16
GND	E21
GND	E5
GND	E8
GND	H1
GND	H21
GND	H25
GND	K21
GND	K23
GND	K3
GND	L11
GND	L12
GND	L13
GND	L14
GND	L15

*Note: *Not routed on the same package layer and to adjacent LGA pads as its differential pair complement. Recommended to be used as a single-ended I/O.*

Revision	Changes	Page
Revision 12 (v2.4)	Revised ordering information and timing data to reflect phase out of –3 speed grade options.	
	Table 2-3 was updated.	2
Revision 11 (v2.3)	The "Packaging Data" section is new.	iv
	Table 2-2 was updated.	2-1
	"VCCDA Supply Voltage" was updated.	2-9
	"PRA/B/C/D Probe A, B, C and D" was updated.	2-10
	The "User I/Os" was updated.	2-11
Revision 10 (v2.2)	Figure 1-3 was updated.	1-2
	Table 2-2 was updated.	2-1
	The "Power-Up/Down Sequence" section was updated.	2-1
	Table 2-4 was updated.	2-3
	Table 2-5 was updated.	2-4
	The "Timing Characteristics" section was added.	2-7
	Table 2-7 was updated.	2-7
	Figure 2-1 was updated.	2-8
	The External Setup and Clock-to-Out (Pad-to-Pad) equations in the "Hardwired Clock – Using LVTTL 24 mA High Slew Clock I/O" section were updated.	2-8
	The External Setup and Clock-to-Out (Pad-to-Pad) in the "Routed Clock – Using LVTTL 24 mA High Slew Clock I/O" section were updated.	2-8
	The "Global Pins" section was updated.	2-10
	The "User I/Os" section was updated.	2-11
	Table 2-17 was updated.	2-19
	Figure 2-8 was updated.	2-20
	Figure 2-13 and Figure 2-14 were updated.	2-24
	The following timing parameters were renamed in I/O timing characteristic tables from Table 2-22 to Table 2-60: $t_{IOCLKQ} > t_{ICLKQ}$ $t_{IOCLKY} > t_{OCLKQ}$	2-26 to 2-52
	Timing numbers were updated from Table 2-22 to Table 2-78.	2-26 to 2-69
	The "R-Cell" section was updated.	2-58
	Figure 2-59 was updated.	2-89
	Figure 2-60 was updated.	2-89
	Figure 2-67 was updated.	2-100
	Figure 2-68 was updated.	2-101
	Table 2-89 to Table 2-93 were updated.	2-90 to 2-94
	Table 2-98 to Table 2-102 were updated.	2-102 to 2-106