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Understanding Embedded - FPGAs (Field Programmable Gate Array)

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

Applications of Embedded - FPGAs

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

Details	
Product Status	Obsolete
Number of LABs/CLBs	32256
Number of Logic Elements/Cells	-
Total RAM Bits	294912
Number of I/O	684
Number of Gates	2000000
Voltage - Supply	1.425V ~ 1.575V
Mounting Type	Surface Mount
Operating Temperature	0°C ~ 70°C (TA)
Package / Case	1152-BGA
Supplier Device Package	1152-FPBGA (35x35)
Purchase URL	https://www.e-xfl.com/product-detail/microsemi/ax2000-2fg1152

Axcelerator Family Device Status

Axcelerator® Devices	Status
AX125	Production
AX250	Production
AX500	Production
AX1000	Production
AX2000	Production

Temperature Grade Offerings

Package	AX125	AX250	AX500	AX1000	AX2000
PQ208	–	C, I, M	C, I, M	–	–
CQ208	–	M	M	–	–
CQ256	–	–	–	–	M
FG256	C, I	C, I, M	–	–	–
FG324	C, I	–	–	–	–
CQ352	–	M	M	M	M
FG484	–	C, I, M	C, I, M	C, I, M	–
CG624	–	–	–	M	M
FG676	–	–	C, I, M	C, I, M	–
BG729	–	–	–	C, I, M	–
FG896	–	–	–	C, I, M	C, I, M
FG1152	–	–	–	–	C, I, M

C = Commercial

I = Industrial

M = Military

Speed Grade and Temperature Grade Matrix

Temperature Grade	Std	–1	–2
C	✓	✓	✓
I	✓	✓	✓
M	✓	✓	–

C = Commercial

I = Industrial

M = Military

I/O Standard Electrical Specifications

***Table 2-18* • Input Capacitance**

Symbol	Parameter	Conditions	Min.	Max.	Units
C_{IN}	Input Capacitance	VIN = 0, f = 1.0 MHz		10	pF
C_{INCLK}	Input Capacitance on HCLK and RCLK Pin	VIN = 0, f = 1.0 MHz		10	pF

Table 2-19* • I/O Input Rise Time and Fall Time

Input Buffer	Input Rise/Fall Time (min.)	Input Rise/Fall Time (max.)
LVTTL	No Requirement	50 ns
LVCMOS 2.5V	No Requirement	50 ns
LVCMOS 1.8V	No Requirement	50 ns
LVCMOS 1.5V	No Requirement	50 ns
PCI	No Requirement	50 ns
PCIX	No Requirement	50 ns
GTL+	No Requirement	50 ns
HSTL	No Requirement	50 ns
SSTL2	No Requirement	50 ns
HSTL3	No Requirement	50 ns
LVDS	No Requirement	50 ns
LVPECL	No Requirement	50 ns

*Note: *Input Rise/Fall time applies to all inputs, be it clock or data. Inputs have to ramp up/down linearly, in a monotonic way. Glitches or a plateau may cause double clocking. They must be avoided. For output rise/fall time, refer to the IBIS models for extraction.*

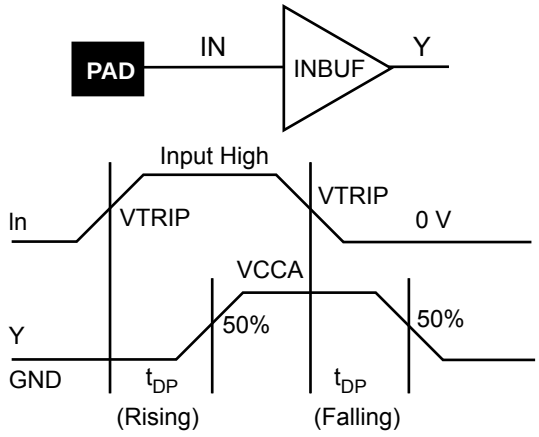


***Figure 2-9 •* Input Buffer Delays**

1.8 V LVCMOS

Low-Voltage Complementary Metal-Oxide Semiconductor for 1.8 V is an extension of the LVCMOS standard (JESD8-5) used for general-purpose 1.8 V applications. It uses a 3.3 V tolerant CMOS input buffer and a push-pull output buffer.

***Table 2-26* • DC Input and Output Levels**

VIL		VIH		VOL	VOH	IOL	IOH
Min., V	**Max., V**	**Min., V**	**Max., V**	**Max., V**	**Min., V**	**mA**	**mA**
–0.3	0.2 VCCI	0.7 VCCI	3.6	0.2	VCCI – 0.2	8 mA	–8 mA

AC Loadings

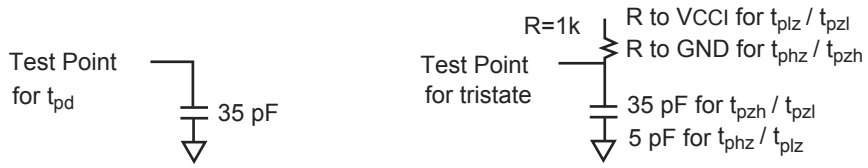


***Figure 2-17* • AC Test Loads**

***Table 2-27* • AC Waveforms, Measuring Points, and Capacitive Loads**

Input Low (V)	Input High (V)	Measuring Point* (V)	VREF (typ) (V)	C_{load} (pF)
0	1.8	0.5 VCCI	N/A	35

*Note: * Measuring Point = VTRIP*

1.5 V LVCMOS (JESD8-11)

Low-Voltage Complementary Metal-Oxide Semiconductor for 1.5 V is an extension of the LVCMOS standard (JESD8-5) used for general-purpose 1.5 V applications. It uses a 3.3 V tolerant CMOS input buffer and a push-pull output buffer.

***Table 2-29* • DC Input and Output Levels**

VIL		VIH		VOL	VOH	IOL	IOH
Min., V	**Max., V**	**Min., V**	**Max., V**	**Max., V**	**Min., V**	**mA**	**mA**
–0.3	0.35 VCCI	0.65 VCCI	3.6	0.4	VCCI – 0.4	8 mA	–8 mA

AC Loadings

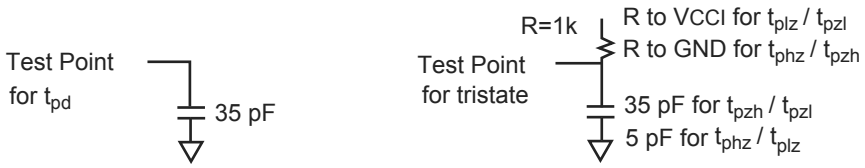


***Table 2-30* • AC Test Loads**

***Table 2-31* • AC Waveforms, Measuring Points, and Capacitive Loads**

Input Low (V)	Input High (V)	Measuring Point* (V)	VREF (typ) (V)	C_{load} (pF)
0	1.5	$0.5V_{CCI}$	N/A	35

*Note: * Measuring Point = VTRIP*

Routing Specifications

Routing Resources

The routing structure found in Axcelerator devices enables any logic module to be connected to any other logic module while retaining high performance. There are multiple paths and routing resources that can be used to route one logic module to another, both within a SuperCluster and elsewhere on the chip.

There are four primary types of routing within the AX architecture: DirectConnect, CarryConnect, FastConnect, and Vertical and Horizontal Routing.

DirectConnect

DirectConnects provide a high-speed connection between an R-cell and its adjacent C-cell (Figure 2-35). This connection can be made from DCOUT of the C-cell to DCIN of the R-cell by configuring of the S1 line of the R-cell. This provides a connection that does not require an antifuse and has a delay of less than 0.1 ns.

Figure 2-35 • **DirectConnect and CarryConnect**

CarryConnect

CarryConnects are used to build carry chains for arithmetic functions (Figure 2-35). The FCO output of the right C-cell of a two-C-cell Cluster drives the FCI input of the left C-cell in the two-C-cell Cluster immediately below it. This pattern continues down both sides of each SuperCluster column.

Similar to the DirectConnects, CarryConnects can be built without an antifuse connection. This connection has a delay of less than 0.1 ns from the FCO of one two-C-cell cluster to the FCI of the two-C-cell cluster immediately below it (see the "Carry-Chain Logic" section on page 2-56 for more information).

FastConnect

For high-speed routing of logic signals, FastConnects can be used to build a short distance connection using a single antifuse (Figure 2-36 on page 2-62). FastConnects provide a maximum delay of 0.3 ns. The outputs of each logic module connect directly to the Output Tracks within a SuperCluster. Signals on the Output Tracks can then be routed through a single antifuse connection to drive the inputs of logic modules either within one SuperCluster or in the SuperCluster immediately below it.

***Table 2-77* • AX500 Routed Array Clock Networks**
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**
Routed Array Clock Networks								
t_{RCKL}	Input Low to High		2.31		2.63		3.09	ns
t_{RCKH}	Input High to Low		2.44		2.78		3.27	ns
t_{RPWH}	Minimum Pulse Width High	0.57		0.64		0.75		ns
t_{RPWL}	Minimum Pulse Width Low	0.52		0.59		0.69		ns
t_{RCKSW}	Maximum Skew		0.35		0.39		0.46	ns
t_{RP}	Minimum Period	1.15		1.31		1.54		ns
t_{RMAX}	Maximum Frequency		870		763		649	MHz

***Table 2-78* • AX1000 Routed Array Clock Networks**
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**
Routed Array Clock Networks								
t_{RCKL}	Input Low to High		3.08		3.50		4.12	ns
t_{RCKH}	Input High to Low		3.13		3.56		4.19	ns
t_{RPWH}	Minimum Pulse Width High	0.57		0.64		0.75		ns
t_{RPWL}	Minimum Pulse Width Low	0.52		0.59		0.69		ns
t_{RCKSW}	Maximum Skew		0.35		0.39		0.46	ns
t_{RP}	Minimum Period	1.15		1.31		1.54		ns
t_{RMAX}	Maximum Frequency		870		763		649	MHz

***Table 2-79* • AX2000 Routed Array Clock Networks**
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**
Routed Array Clock Networks								
t_{RCKL}	Input Low to High		3.08		3.50		4.12	ns
t_{RCKH}	Input High to Low		3.13		3.56		4.19	ns
t_{RPWH}	Minimum Pulse Width High	0.57		0.64		0.75		ns
t_{RPWL}	Minimum Pulse Width Low	0.52		0.59		0.69		ns
t_{RCKSW}	Maximum Skew		0.35		0.39		0.46	ns
t_{RP}	Minimum Period	1.15		1.31		1.54		ns
t_{RMAX}	Maximum Frequency		870		763		649	MHz

single-ended, or voltage-referenced standard. The [H]CLKxN pad can only be used as a differential pair with [H]CLKxP.

The block marked “/i Delay Match” is a fixed delay equal to that of the i divider. The “/j Delay Match” block has the same function as its j divider counterpart.

Functional Description

Figure 2-48 on page 2-75 illustrates a block diagram of the PLL. The PLL contains two dividers, i and j, that allow frequency scaling of the clock signal:

- The i divider in the feedback path allows multiplication of the input clock by integer factors ranging from 1 to 64, and the resultant frequency is available at the output of the PLL block.
- The j divider divides the PLL output by integer factors ranging from 1 to 64, and the divided clock is available at CLK1.
- The two dividers together can implement any combination of multiplication and division up to a maximum frequency of 1 GHz on CLK1. Both the CLK1 and CLK2 outputs have a fixed 50/50 duty cycle.
- The output frequencies of the two clocks are given by the following formulas (f_{REF} is the reference clock frequency):

$$f_{CLK1} = f_{REF} * (DividerI) / (DividerJ)$$

EQ 4

$$f_{CLK2} = f_{REF} * (DividerI)$$

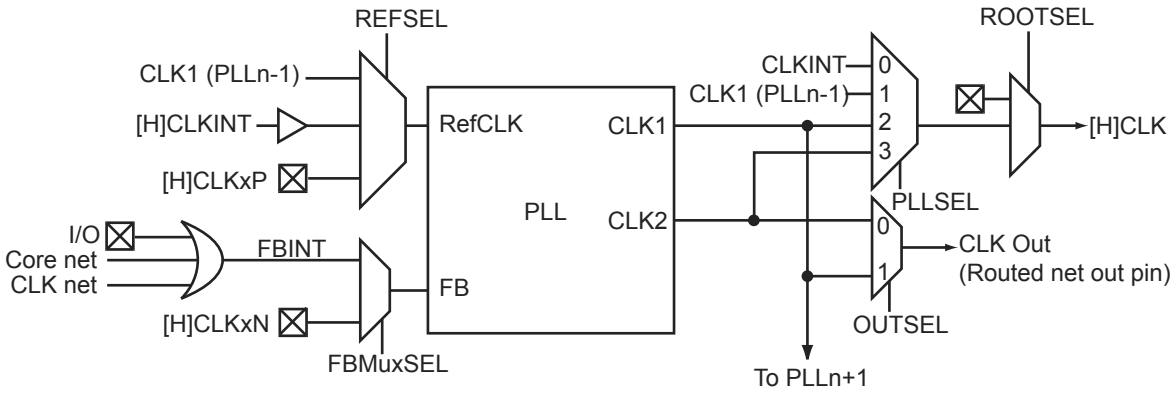
EQ 5

- CLK2 provides the PLL output directly—without division

The input and output frequency ranges are selected by LowFreq and Osc(2:0), respectively. These functions and their possible values are detailed in Table 2-80 on page 2-77.

The delay lines shown in Figure 2-48 on page 2-75 are programmable. The feedback clock path can be delayed (using the five DelayLine bits) relative to the reference clock (or vice versa) by up to 3.75 ns in increments of 250 ps. Table 2-80 on page 2-77 describes the usage of these bits. The delay increments are independent of frequency, so this results in phase changes that vary with frequency. The delay value is highly dependent on V_{CC} and the speed grade.

Figure 2-49 is a logical diagram of the various control signals to the PLL and shows how the PLL interfaces with the global and routing networks of the FPGA. Note that not all signals are user-accessible. These non-user-accessible signals are used by the place-and-route tool to control the configuration of the PLL. The user gains access to these control signals either based upon the connections built in the user's design or through the special macros (Table 2-84 on page 2-81) inserted into the design. For example, connecting the macro PLLOUT to CLK2 will control the OUTSEL signal.



Note: Not all signals are available to the user.

Figure 2-49 • **PLL Logical Interface**

TDO

TDO is normally tristated, and it is active only when the TAP controller is in the "Shift_DR" state or "Shift_IR" state. The least significant bit of the selected register (i.e. IR or DR) is clocked out to TDO first by the falling edge of TCK.

TAP Controller

The TAP Controller is compliant with the IEEE Standard 1149.1. It is a state machine of 16 states that controls the Instruction Register (IR) and the Data Registers (such as BSR, IDCODE, USRCODE, BYPASS, etc.). The TAP Controller steps into one of the states depending on the sequence of TMS at the rising edges of TCK.

Instruction Register (IR)

The IR has five bits (IR4 to IR0). At the TRST state, IR is reset to IDCODE. Each time when IR is selected, it goes through "select IR-Scan," "Capture-IR," "Shift-IR," all the way through "Update-IR." When there is no test error, the first five data bits coming out of TDO during the "Shift-IR" will be "10111". If a test error occurs, the last three bits will contain one to three zeroes corresponding to negatively asserted signals: "TDO_ERRORB," "PROBA_ERRORB," and "PROBB_ERRORB." The error(s) will be erased when the TAP is at the "Update-IR" or the TRST state. When in user mode start-up sequence, if the micro-probe has not been used, the "PROBA_ERRORB" is used as a "Power-up done successfully" flag.

Data Registers (DRs)

Data registers are distributed throughout the chip. They store testing/programming vectors. The MSB of a data register is connected to TDI, while the LSB is connected to TDO. There are different types of data registers. Descriptions of the main registers are as follow:

1. IDCODE:

   The IDCODE is a 20-bit hard coded JTAG Silicon Signature. It is a hardwired device ID code, which contains the Microsemi identity, part number, and version number in a specific JTAG format.

2. USERCODE:

   The USERCODE is a 33-bit programmable register. However, only 20 bits are allocated to use as JTAG Silicon Signature. It is a supplementary identity code for the user to program information to distinguish different programmed parts. USERCODE fuses will read out as "zeroes" when not programmed, so only the "1" bits need to be programmed.

3. Boundary-Scan Register (BSR):

   Each I/O contains three Boundary-Scan Cells. Each cell has a shift register bit, a latch, and two MUXes. The boundary-scan cells are used for the Output-enable (E), Output (O), and Input (I) registers. The bit order of the boundary-scan cells for each of them is E-O-I. The boundary-scan cells are then chained serially to form the Boundary-Scan Register (BSR). The length of the BSR is the number of I/Os in the die multiplied by three.

4. Bypass Register (BYR):

   This is the "1-bit" register. It is used to shorten the TDI-TDO serial chain in board-level testing to only one bit per device not being tested. It is also selected for all "reserved" or unused instructions.

Probing

Internal activities of the JTAG interface can be observed via the Silicon Explorer II probes: "PRA," "PRB," "PRC," and "PRD."

Special Fuses

Security

Microsemi antifuse FPGAs, with FuseLock technology, offer the highest level of design security available in a programmable logic device. Since antifuse FPGAs are live-at power-up, there is no bitstream that can be intercepted, and no bitstream or programming data is ever downloaded to the device during power-up, thus protecting against device cloning. In addition, special security fuses are hidden

BG729	
AX1000 Function	Pin Number
IO109NB3F10	V24
IO109PB3F10	V25
IO110NB3F10	T20
IO110PB3F10	T21
IO111NB3F10	W26
IO111PB3F10	W27
IO112NB3F10	U22
IO112PB3F10	U23
IO113NB3F10	Y26
IO113PB3F10	Y27
IO114NB3F10	U20
IO114PB3F10	U21
IO115NB3F10	W24
IO115PB3F10	W25
IO116NB3F10	V22
IO116PB3F10	V23
IO117NB3F10	Y24
IO117PB3F10	Y25
IO118NB3F11	V20
IO118PB3F11	V21
IO119NB3F11	AA26
IO119PB3F11	AA27
IO120NB3F11	W22
IO120PB3F11	W23
IO121NB3F11	AA24
IO121PB3F11	AA25
IO122NB3F11	W20
IO122PB3F11	W21
IO123NB3F11	AB26
IO123PB3F11	AB27
IO124NB3F11	Y22
IO124PB3F11	Y23
IO125NB3F11	AB24
IO125PB3F11	AB25
IO126NB3F11	AA22
IO126PB3F11	AA23
IO127NB3F11	AC26

BG729	
AX1000 Function	Pin Number
IO127PB3F11	AC27
IO128NB3F11	Y20
IO128PB3F11	W19
Bank 4	
IO129NB4F12	AA20
IO129PB4F12	Y21
IO130NB4F12	AB22
IO130PB4F12	AB23
IO131NB4F12	AC22
IO131PB4F12	AC23
IO132NB4F12	AD23
IO132PB4F12	AD24
IO133NB4F12	AF23
IO133PB4F12	AE23
IO134NB4F12	AC21
IO134PB4F12	AB21
IO135NB4F12	AC20
IO135PB4F12	AB20
IO136NB4F12	AD21
IO136PB4F12	AD22
IO137NB4F12	Y19
IO137PB4F12	AA19
IO138NB4F12	AE21
IO138PB4F12	AE22
IO139NB4F13	AF21
IO139PB4F13	AF22
IO140NB4F13	AG22
IO140PB4F13	AG23
IO141NB4F13	Y18
IO141PB4F13	AA18
IO142NB4F13	AE20
IO142PB4F13	AD20
IO143NB4F13	AG20
IO143PB4F13	AG21
IO144NB4F13	AC19
IO144PB4F13	AB19
IO145NB4F13	AD18

BG729	
AX1000 Function	Pin Number
IO145PB4F13	AD19
IO146NB4F13	AC18
IO146PB4F13	AB18
IO147NB4F13	Y17
IO147PB4F13	AA17
IO148NB4F13	AF19
IO148PB4F13	AF20
IO149NB4F13	AC17
IO149PB4F13	AB17
IO150NB4F13	AE18
IO150PB4F13	AE19
IO151NB4F13	AA16
IO151PB4F13	Y16
IO152NB4F14	AG18
IO152PB4F14	AG19
IO153NB4F14	AC16
IO153PB4F14	AB16
IO154NB4F14	AF17
IO154PB4F14	AF18
IO155NB4F14	AB15
IO155PB4F14	AC15
IO156NB4F14	AE16
IO156PB4F14	AE17
IO157NB4F14	Y15
IO157PB4F14	AA15
IO158NB4F14	AG16
IO158PB4F14	AG17
IO159NB4F14/CLKEN	AF15
IO159PB4F14/CLKEP	AF16
IO160NB4F14/CLKFN	AD14
IO160PB4F14/CLKFP	AD15
Bank 5	
IO161NB5F15/CLKGN	AE14
IO161PB5F15/CLKGP	AE15
IO162NB5F15/CLKHN	AC13
IO162PB5F15/CLKHP	AD13
IO163NB5F15	Y14

BG729	
AX1000 Function	Pin Number
IO218PB6F20	V2
IO219NB6F20	T1
IO219PB6F20	U1
IO220NB6F20	R5
IO220PB6F20	R6
IO221NB6F20	T3
IO221PB6F20	T4
IO222NB6F20	R2
IO222PB6F20	T2
IO223NB6F20	P8
IO223PB6F20	P9
IO224NB6F20	R3
IO224PB6F20	R4
Bank 7	
IO225NB7F21	P1
IO225PB7F21	R1
IO226NB7F21	P3
IO226PB7F21	P2
IO227NB7F21	N7
IO227PB7F21	P7
IO228NB7F21	P5
IO228PB7F21	P4
IO229NB7F21	N2
IO229PB7F21	N1
IO230NB7F21	N6
IO230PB7F21	P6
IO231NB7F21	N9
IO231PB7F21	N8
IO232NB7F21	N4
IO232PB7F21	N3
IO233NB7F21	M2
IO233PB7F21	M1
IO234NB7F21	M4
IO234PB7F21	M3
IO235NB7F21	M5
IO235PB7F21	N5
IO236NB7F22	L2

BG729	
AX1000 Function	Pin Number
IO236PB7F22	L1
IO237NB7F22	L4
IO237PB7F22	L3
IO238NB7F22	L6
IO238PB7F22	M6
IO239NB7F22	M8
IO239PB7F22	M7
IO240NB7F22	K2
IO240PB7F22	K1
IO241NB7F22	K4
IO241PB7F22	K3
IO242NB7F22	K5
IO242PB7F22	L5
IO243NB7F22	J2
IO243PB7F22	J1
IO244NB7F22	J4
IO244PB7F22	J3
IO245NB7F22	H2
IO245PB7F22	H1
IO246NB7F22	H4
IO246PB7F22	H3
IO247NB7F23	L8
IO247PB7F23	L7
IO248NB7F23	J6
IO248PB7F23	K6
IO249NB7F23	H5
IO249PB7F23	J5
IO250NB7F23	G2
IO250PB7F23	G1
IO251NB7F23	K8
IO251PB7F23	K7
IO252NB7F23	G4
IO252PB7F23	G3
IO253NB7F23	F2
IO253PB7F23	F1
IO254NB7F23	G6
IO254PB7F23	H6

BG729	
AX1000 Function	Pin Number
IO255NB7F23	F5
IO255PB7F23	G5
IO256NB7F23	F3
IO256PB7F23	F4
IO257NB7F23	H7
IO257PB7F23	J7
Dedicated I/O	
GND	A1
GND	A2
GND	A25
GND	A26
GND	A27
GND	A3
GND	AC24
GND	AE1
GND	AE2
GND	AE25
GND	AE26
GND	AE27
GND	AE3
GND	AE5
GND	AF1
GND	AF2
GND	AF25
GND	AF26
GND	AF27
GND	AF3
GND	AG1
GND	AG2
GND	AG25
GND	AG26
GND	AG27
GND	AG3
GND	B1
GND	B2
GND	B25
GND	B26

FG256-Pin FBGA	
AX125 Function	**Pin Number**
Bank 0	
IO01NB0F0	B4
IO01PB0F0	B3
IO03NB0F0	A4
IO03PB0F0	A3
IO04NB0F0	B6
IO04PB0F0	B5
IO06NB0F0	A6
IO06PB0F0	A5
IO07NB0F0/HCLKAN	B8
IO07PB0F0/HCLKAP	B7
IO08NB0F0/HCLKBN	A9
IO08PB0F0/HCLKBP	A8
Bank 1	
IO09NB1F1/HCLKCN	C10
IO09PB1F1/HCLKCP	C9
IO10NB1F1/HCLKDN	B11
IO10PB1F1/HCLKDP	B10
IO12NB1F1	A13
IO12PB1F1	A12
IO13NB1F1	B13
IO13PB1F1	B12
IO14NB1F1	C12
IO14PB1F1	C11
IO15NB1F1	A15
IO15PB1F1	B14
IO16NB1F1	C15
IO16PB1F1	C14
IO17NB1F1	D13
IO17PB1F1	D12
Bank 2	
IO18NB2F2	F13
IO18PB2F2	E13
IO19NB2F2	F14
IO19PB2F2	E14

FG256-Pin FBGA	
AX125 Function	**Pin Number**
IO20NB2F2	F15
IO20PB2F2	E15
IO21NB2F2	C16
IO21PB2F2	B16
IO22NB2F2	H13
IO22PB2F2	G13
IO23NB2F2	E16
IO23PB2F2	D16
IO25NB2F2	H15
IO25PB2F2	G15
IO26NB2F2	H14
IO26PB2F2	G14
IO27NB2F2	G16
IO27PB2F2	F16
IO28NB2F2	K15
IO28PB2F2	K16
IO29NB2F2	J16
IO29PB2F2	H16
Bank 3	
IO30NB3F3	K13
IO30PB3F3	J13
IO31NB3F3	K14
IO31PB3F3	J14
IO33NB3F3	L15
IO33PB3F3	L16
IO35NB3F3	P16
IO35PB3F3	N16
IO36PB3F3	M16
IO37NB3F3	P15
IO37PB3F3	R16
IO39NB3F3	N15
IO39PB3F3	M15
IO40NB3F3	M13
IO40PB3F3	L13
IO41NB3F3	M14

FG256-Pin FBGA	
AX125 Function	**Pin Number**
IO41PB3F3	L14
Bank 4	
IO42NB4F4	N12
IO42PB4F4	N13
IO43NB4F4	T14
IO43PB4F4	R14
IO44PB4F4	T15
IO45NB4F4	R12
IO45PB4F4	R13
IO46NB4F4	P11
IO46PB4F4	P12
IO47PB4F4	T11
IO48NB4F4	T12
IO48PB4F4	T13
IO49NB4F4/CLKEN	R9
IO49PB4F4/CLKEP	R10
IO50NB4F4/CLKFN	T8
IO50PB4F4/CLKFP	T9
Bank 5	
IO51NB5F5/CLKGN	P7
IO51PB5F5/CLKGP	P8
IO52NB5F5/CLKHN	R6
IO52PB5F5/CLKHP	R7
IO54NB5F5	T5
IO54PB5F5	T6
IO55NB5F5	P5
IO55PB5F5	P6
IO56NB5F5	T3
IO56PB5F5	T4
IO57NB5F5	R3
IO57PB5F5	R4
IO58NB5F5	R1
IO58PB5F5	T2
IO59NB5F5	N4
IO59PB5F5	N5

FG324	
AX125 Function	**Pin Number**
IO50NB4F4/CLKFN	U9
IO50PB4F4/CLKFP	U10
Bank 5	
IO51NB5F5/CLKGN	R8
IO51PB5F5/CLKGP	R9
IO52NB5F5/CLKHN	T7
IO52PB5F5/CLKHP	T8
IO53NB5F5	U6
IO53PB5F5	U7
IO54NB5F5	V8
IO54PB5F5	V9
IO55NB5F5	V6
IO55PB5F5	V7
IO56NB5F5	U4
IO56PB5F5	U5
IO57NB5F5	T4
IO57PB5F5	T5
IO58NB5F5	V4
IO58PB5F5	V5
IO59NB5F5	V2
IO59PB5F5	V3
Bank 6	
IO60NB6F6	P5
IO60PB6F6	P6
IO61NB6F6	T2
IO61PB6F6	U3
IO62NB6F6	T1
IO62PB6F6	U1
IO63NB6F6	P1
IO63PB6F6	R1
IO64NB6F6	R3
IO64PB6F6	P3
IO65NB6F6	P2
IO65PB6F6	R2
IO66NB6F6	M3

FG324	
AX125 Function	**Pin Number**
IO66PB6F6	N3
IO67NB6F6	M2
IO67PB6F6	N2
IO68NB6F6	M1
IO68PB6F6	N1
IO69NB6F6	K4
IO69PB6F6	L4
IO70NB6F6	K1
IO70PB6F6	L1
IO71NB6F6	K3
IO71PB6F6	L3
Bank 7	
IO72NB7F7	H4
IO72PB7F7	J4
IO73NB7F7	K2
IO73PB7F7	L2
IO74NB7F7	H2
IO74PB7F7	H1
IO75NB7F7	H3
IO75PB7F7	J3
IO76NB7F7	F2
IO76PB7F7	G2
IO77NB7F7	F1
IO77PB7F7	G1
IO78NB7F7	D2
IO78PB7F7	E2
IO79NB7F7	F3
IO79PB7F7	G3
IO80NB7F7	E3
IO80PB7F7	E4
IO81NB7F7	D1
IO81PB7F7	E1
IO82NB7F7	D3
IO82PB7F7	C2
IO83NB7F7	B1

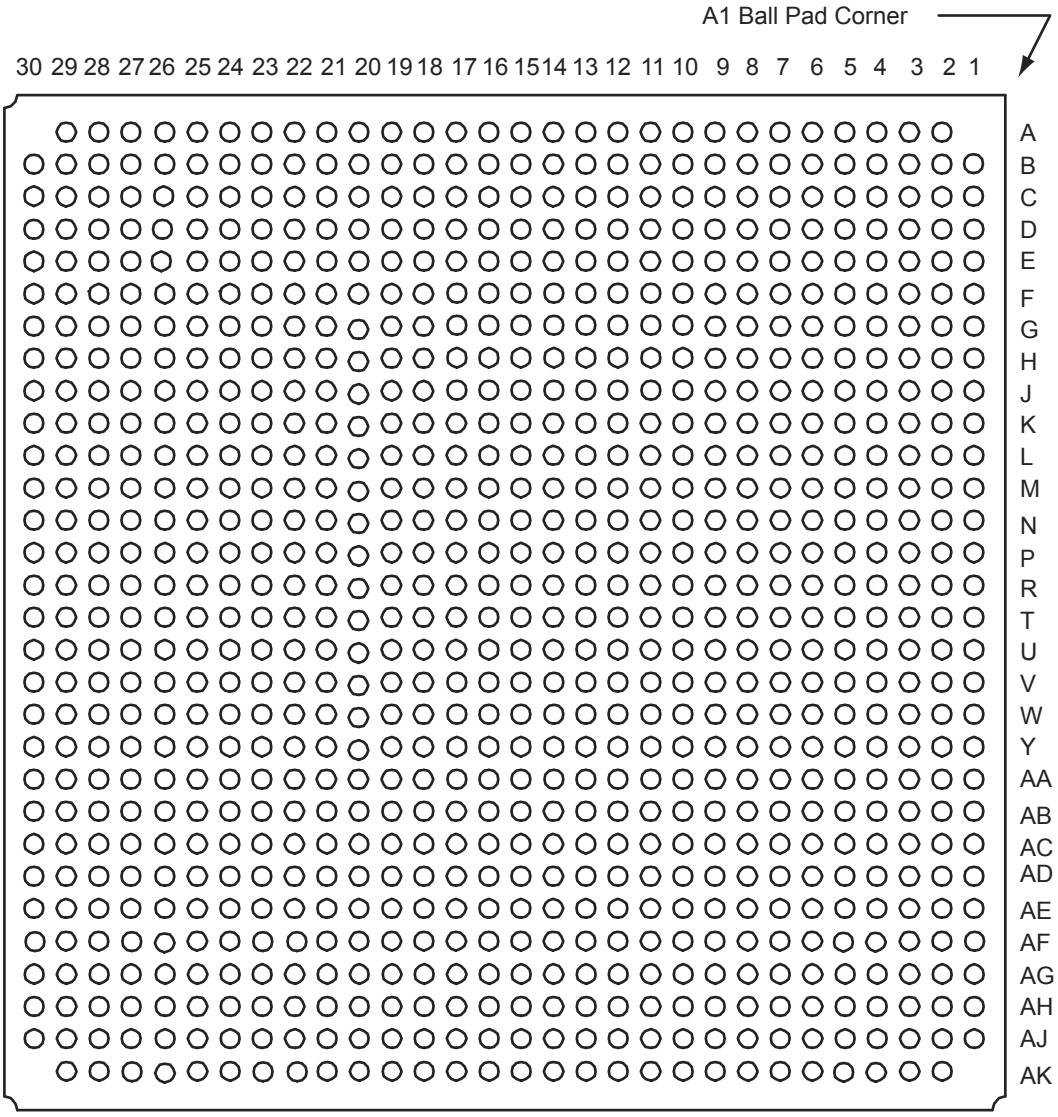
FG324	
AX125 Function	**Pin Number**
IO83PB7F7	C1
Dedicated I/O	
VCCDA	F5
GND	A1
GND	A18
GND	B17
GND	B2
GND	C16
GND	C3
GND	E16
GND	F13
GND	F6
GND	G12
GND	G7
GND	H10
GND	H11
GND	H8
GND	H9
GND	J10
GND	J11
GND	J8
GND	J9
GND	K10
GND	K11
GND	K8
GND	K9
GND	L10
GND	L11
GND	L8
GND	L9
GND	M12
GND	M7
GND	N13
GND	N6
GND	R14

FG676	
AX500 Function	**Pin Number**
IO153PB7F14	M6
IO154NB7F14	K2
IO154PB7F14	L2
IO155NB7F14	K3
IO155PB7F14	L3
IO156NB7F14	L5
IO156PB7F14	L4
IO157NB7F14	L6
IO157PB7F14	L7
IO158NB7F15	J1
IO158PB7F15	K1
IO159NB7F15	J4
IO159PB7F15	K4
IO160NB7F15	H2
IO160PB7F15	J2
IO161NB7F15	K6
IO161PB7F15	K5
IO162NB7F15	H3
IO162PB7F15	J3
IO163NB7F15	G2
IO163PB7F15	G1
IO164NB7F15	G4
IO164PB7F15	H4
IO165NB7F15	F3
IO165PB7F15	G3
IO166NB7F15	E2
IO166PB7F15	F2
IO167NB7F15	F5
IO167PB7F15	G5
Dedicated I/O	
GND	A1
GND	A13
GND	A14
GND	A19
GND	A26

FG676	
AX500 Function	**Pin Number**
GND	A8
GND	AC23
GND	AC4
GND	AD24
GND	AD3
GND	AE2
GND	AE25
GND	AF1
GND	AF13
GND	AF14
GND	AF19
GND	AF26
GND	AF8
GND	B2
GND	B25
GND	B26
GND	C24
GND	C3
GND	G20
GND	G7
GND	H1
GND	H19
GND	H26
GND	H8
GND	J18
GND	J9
GND	K10
GND	K11
GND	K12
GND	K13
GND	K14
GND	K15
GND	K16
GND	K17
GND	L10

FG676	
AX500 Function	**Pin Number**
GND	L11
GND	L12
GND	L13
GND	L14
GND	L15
GND	L16
GND	L17
GND	M10
GND	M11
GND	M12
GND	M13
GND	M14
GND	M15
GND	M16
GND	M17
GND	N1
GND	N10
GND	N11
GND	N12
GND	N13
GND	N14
GND	N15
GND	N16
GND	N17
GND	N26
GND	P1
GND	P10
GND	P11
GND	P12
GND	P13
GND	P14
GND	P15
GND	P16
GND	P17
GND	P26

FG896



Note

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

FG1152	
AX2000 Function	Pin Number
IO155PB3F14	AC29
IO156NB3F14	AE30
IO156PB3F14	AD30
IO157NB3F14	AC26
IO157PB3F14	AB26
IO158NB3F14	AH33
IO158PB3F14	AG33
IO159NB3F14	AD27
IO159PB3F14	AC27
IO160NB3F14	AG32
IO160PB3F14	AF32
IO161NB3F15	AG31
IO161PB3F15	AF31
IO162NB3F15	AF29
IO162PB3F15	AE29
IO163NB3F15	AE28
IO163PB3F15	AD28
IO164NB3F15	AG30
IO164PB3F15	AF30
IO165NB3F15	AE26
IO165PB3F15	AD26
IO166NB3F15	AJ30
IO166PB3F15	AH30
IO167NB3F15	AG28
IO167PB3F15	AF28
IO168NB3F15	AF27
IO168PB3F15	AE27
IO169NB3F15	AH29
IO169PB3F15	AG29
IO170NB3F15	AD25
IO170PB3F15	AC25
Bank 4	
IO171NB4F16	AP29
IO171PB4F16	AN29
IO172NB4F16	AH26

FG1152	
AX2000 Function	Pin Number
IO172PB4F16	AH27
IO173NB4F16	AJ27
IO173PB4F16	AJ28
IO174NB4F16	AL27
IO174PB4F16	AL28
IO175NB4F16	AM28
IO175PB4F16	AM29
IO176NB4F16	AG25
IO176PB4F16	AG26
IO177NB4F16	AK26
IO177PB4F16	AK27
IO178NB4F16	AF25
IO178PB4F16	AE25
IO179NB4F16	AP28
IO179PB4F16	AN28
IO180NB4F16	AJ25
IO180PB4F16	AJ26
IO181NB4F17	AM26
IO181PB4F17	AM27
IO182NB4F17	AF24
IO182PB4F17	AE24
IO183NB4F17	AH24
IO183PB4F17	AH25
IO184NB4F17	AG23
IO184PB4F17	AG24
IO185NB4F17	AL25
IO185PB4F17	AL26
IO186NB4F17	AP25
IO186PB4F17	AP26
IO187NB4F17	AK24
IO187PB4F17	AK25
IO188NB4F17	AF23
IO188PB4F17	AE23
IO189NB4F17	AN24
IO189PB4F17	AM24

FG1152	
AX2000 Function	Pin Number
IO190NB4F17	AH22
IO190PB4F17	AH23
IO191NB4F17	AJ23
IO191PB4F17	AJ24
IO192NB4F17	AG21
IO192PB4F17	AG22
IO193NB4F18	AP23
IO193PB4F18	AP24
IO194NB4F18	AN22
IO194PB4F18	AN23
IO195NB4F18	AM23
IO195PB4F18	AL23
IO196NB4F18	AF21
IO196PB4F18	AF22
IO197NB4F18	AL22
IO197PB4F18	AM22
IO198NB4F18	AE21
IO198PB4F18	AE22
IO199NB4F18	AJ21
IO199PB4F18	AJ22
IO200NB4F18	AK21
IO200PB4F18	AK22
IO201NB4F18	AM21
IO201PB4F18	AL21
IO202NB4F18	AE20
IO202PB4F18	AD20
IO203NB4F19	AN21
IO203PB4F19	AP21
IO204NB4F19	AP20
IO204PB4F19	AN20
IO205NB4F19	AN19
IO205PB4F19	AP19
IO206NB4F19	AG20
IO206PB4F19	AF20
IO207NB4F19	AL19

FG1152	
AX2000 Function	Pin Number
NC	AP9
NC	B17
NC	B22
NC	B27
NC	B8
NC	D10
NC	D20
NC	D23
NC	D25
NC	F3
NC	F32
NC	F33
NC	F34
NC	F4
NC	G1
NC	G32
NC	G33
NC	G34
NC	H31
NC	H33
NC	J1
NC	J3
NC	J34
NC	M1
NC	M4
NC	P1
NC	P2
NC	R31
NC	T1
NC	T2
NC	V3
NC	V34
NC	W3
NC	W34
PRA	J17

FG1152	
AX2000 Function	Pin Number
PRB	F18
PRC	AD18
PRD	AH18
TCK	J9
TDI	F7
TDO	L10
TMS	H8
TRST	E6
VCCA	AA13
VCCA	AA22
VCCA	AB14
VCCA	AB15
VCCA	AB16
VCCA	AB17
VCCA	AB18
VCCA	AB19
VCCA	AB20
VCCA	AB21
VCCA	AF8
VCCA	AK28
VCCA	G30
VCCA	G5
VCCA	N14
VCCA	N15
VCCA	N16
VCCA	N17
VCCA	N18
VCCA	N19
VCCA	N20
VCCA	N21
VCCA	P13
VCCA	P22
VCCA	R13
VCCA	R22
VCCA	T13

FG1152	
AX2000 Function	Pin Number
VCCA	T22
VCCA	U13
VCCA	U22
VCCA	V13
VCCA	V22
VCCA	W13
VCCA	W22
VCCA	Y13
VCCA	Y22
VCCDA	AF26
VCCDA	AF9
VCCDA	AG17
VCCDA	AG18
VCCDA	AH14
VCCDA	AH15
VCCDA	AH17
VCCDA	AH20
VCCDA	AH21
VCCDA	AK29
VCCDA	AK6
VCCDA	E15
VCCDA	E29
VCCDA	E7
VCCDA	F15
VCCDA	F21
VCCDA	F5
VCCDA	G20
VCCDA	H17
VCCDA	H18
VCCDA	H28
VCCDA	J18
VCCDA	V27
VCCDA	V6
VCCIB0	A5
VCCIB0	B5

FG1152	
AX2000 Function	Pin Number
VCCIB0	C5
VCCIB0	D5
VCCIB0	L12
VCCIB0	L13
VCCIB0	L14
VCCIB0	M13
VCCIB0	M14
VCCIB0	M15
VCCIB0	M16
VCCIB0	M17
VCCIB1	A30
VCCIB1	B30
VCCIB1	C30
VCCIB1	D30
VCCIB1	L21
VCCIB1	L22
VCCIB1	L23
VCCIB1	M18
VCCIB1	M19
VCCIB1	M20
VCCIB1	M21
VCCIB1	M22
VCCIB2	E31
VCCIB2	E32
VCCIB2	E33
VCCIB2	E34
VCCIB2	M24
VCCIB2	N23
VCCIB2	N24
VCCIB2	P23
VCCIB2	P24
VCCIB2	R23
VCCIB2	T23
VCCIB2	U23
VCCIB3	AA23

FG1152	
AX2000 Function	Pin Number
VCCIB3	AA24
VCCIB3	AB23
VCCIB3	AB24
VCCIB3	AC24
VCCIB3	AK31
VCCIB3	AK32
VCCIB3	AK33
VCCIB3	AK34
VCCIB3	V23
VCCIB3	W23
VCCIB3	Y23
VCCIB4	AC18
VCCIB4	AC19
VCCIB4	AC20
VCCIB4	AC21
VCCIB4	AC22
VCCIB4	AD21
VCCIB4	AD22
VCCIB4	AD23
VCCIB4	AL30
VCCIB4	AM30
VCCIB4	AN30
VCCIB4	AP30
VCCIB5	AC13
VCCIB5	AC14
VCCIB5	AC15
VCCIB5	AC16
VCCIB5	AC17
VCCIB5	AD12
VCCIB5	AD13
VCCIB5	AD14
VCCIB5	AL5
VCCIB5	AM5
VCCIB5	AN5
VCCIB5	AP5

FG1152	
AX2000 Function	Pin Number
VCCIB6	AA11
VCCIB6	AA12
VCCIB6	AB11
VCCIB6	AB12
VCCIB6	AC11
VCCIB6	AK1
VCCIB6	AK2
VCCIB6	AK3
VCCIB6	AK4
VCCIB6	V12
VCCIB6	W12
VCCIB6	Y12
VCCIB7	E1
VCCIB7	E2
VCCIB7	E3
VCCIB7	E4
VCCIB7	M11
VCCIB7	N11
VCCIB7	N12
VCCIB7	P11
VCCIB7	P12
VCCIB7	R12
VCCIB7	T12
VCCIB7	U12
VCCPLA	J16
VCCPLB	K17
VCCPLC	J19
VCCPLD	L18
VCCPLE	AK19
VCCPLF	AE18
VCCPLG	AK16
VCCPLH	AF17
VCOMPLA	H16
VCOMPLB	L17
VCOMPLC	H19

PQ208	
AX250 Function	**Pin Number**
IO110PB7F7	19
IO112NB7F7	16
IO112PB7F7	17
IO117NB7F7	12
IO117PB7F7	13
IO119NB7F7	10
IO119PB7F7	11
IO121PB7F7	7
IO122NB7F7	5
IO122PB7F7	6
IO123NB7F7	3
IO123PB7F7	4
Dedicated I/O	
VCCDA	1
VCCDA	26
VCCDA	53
VCCDA	63
VCCDA	78
VCCDA	95
VCCDA	105
VCCDA	130
VCCDA	157
VCCDA	167
VCCDA	182
VCCDA	202
GND	104
GND	9
GND	15
GND	21
GND	32
GND	39
GND	46
GND	51
GND	59
GND	65
GND	69
GND	90

PQ208	
AX250 Function	**Pin Number**
GND	94
GND	99
GND	113
GND	119
GND	125
GND	136
GND	143
GND	150
GND	155
GND	164
GND	169
GND	173
GND	194
GND	196
GND	201
GND/LP	208
PRA	184
PRB	183
PRC	80
PRD	79
TCK	205
TDI	204
TDO	203
TMS	206
TRST	207
VCCA	2
VCCA	52
VCCA	156
VCCA	14
VCCA	38
VCCA	64
VCCA	93
VCCA	118
VCCA	142
VCCA	168
VCCA	195
VCCPLA	189

PQ208	
AX250 Function	**Pin Number**
VCCPLB	187
VCCPLC	178
VCCPLD	176
VCCPLE	85
VCCPLF	83
VCCPLG	74
VCCPLH	72
VCCIB0	193
VCCIB0	200
VCCIB1	163
VCCIB1	172
VCCIB2	135
VCCIB2	149
VCCIB3	112
VCCIB3	124
VCCIB4	89
VCCIB4	98
VCCIB5	58
VCCIB5	68
VCCIB6	31
VCCIB6	45
VCCIB7	8
VCCIB7	20
VCOMPLA	190
VCOMPLB	188
VCOMPLC	179
VCOMPLD	177
VCOMPLE	86
VCOMPLF	84
VCOMPLG	75
VCOMPLH	73
VPUMP	158

CQ256	
AX2000 Function	Pin Number
Bank 0	
IO01NB0F0	248
IO01PB0F0	249
IO04NB0F0	246
IO04PB0F0	247
IO05NB0F0	242
IO05PB0F0	243
IO08NB0F0	240
IO08PB0F0	241
Bank 0	
IO37NB0F3	234
IO37PB0F3	235
IO41NB0F3/HCLKAN	232
IO41PB0F3/HCLKAP	233
IO42NB0F3/HCLKBN	228
IO42PB0F3/HCLKBP	229
Bank 1 -	
IO43NB1F4/HCLKCN	220
IO43PB1F4/HCLKCP	221
IO44NB1F4/HCLKDN	216
IO44PB1F4/HCLKDP	217
Bank 1	
IO65NB1F6	210
IO65PB1F6	211
IO69NB1F6	208
IO69PB1F6	209
IO70NB1F6	199
IO71NB1F6	204
IO71PB1F6	205
IO73NB1F6	202
IO73PB1F6	203
IO74NB1F6	197
IO74PB1F6	198
Bank 2	
IO87NB2F8	187

CQ256	
AX2000 Function	Pin Number
IO87PB2F8	188
IO89PB2F8	186
Bank 2	
IO107NB2F10	184
IO107PB2F10	185
IO110NB2F10	180
IO110PB2F10	181
IO111NB2F10	178
IO111PB2F10	179
IO112NB2F10	174
IO112PB2F10	175
IO113NB2F10	172
IO113PB2F10	173
IO114NB2F10	168
IO114PB2F10	169
IO115NB2F10	166
IO115PB2F10	167
IO117NB2F10	162
IO117PB2F10	163
Bank 3	
IO139NB3F13	158
IO139PB3F13	159
IO141NB3F13	154
IO141PB3F13	155
IO142NB3F13	152
IO142PB3F13	153
IO145NB3F13	148
IO145PB3F13	149
IO146NB3F13	146
IO146PB3F13	147
IO147NB3F13	140
IO147PB3F13	141
IO148NB3F13	142
IO148PB3F13	143
IO149NB3F13	136

CQ256	
AX2000 Function	Pin Number
IO149PB3F13	137
Bank 3	
IO165NB3F15	135
IO167NB3F15	133
IO167PB3F15	134
Bank 4	
IO181NB4F17	124
IO181PB4F17	125
IO182NB4F17	122
IO182PB4F17	123
IO183NB4F17	118
IO183PB4F17	119
IO184NB4F17	116
IO184PB4F17	117
IO190NB4F17	112
IO190PB4F17	113
IO192NB4F17	110
IO192PB4F17	111
Bank 4	
IO212NB4F19/CLKEN	104
IO212PB4F19/CLKEP	105
IO213NB4F19/CLKFN	100
IO213PB4F19/CLKFP	101
Bank 5	
IO214NB5F20/CLKGN	92
IO214PB5F20/CLKGP	93
IO215NB5F20/CLKHN	88
IO215PB5F20/CLKHP	89
Bank 5	
IO236NB5F22	82
IO236PB5F22	83
IO238NB5F22	80
IO238PB5F22	81
IO240NB5F22	76
IO240PB5F22	77