

# QL5130 - QuickPCI™



**33 MHz/32-bit PCI Target with Embedded Programmable Logic and Dual Port SRAM**

*last updated 12/1099*

## DEVICE HIGHLIGHTS

### High Performance PCI Controller

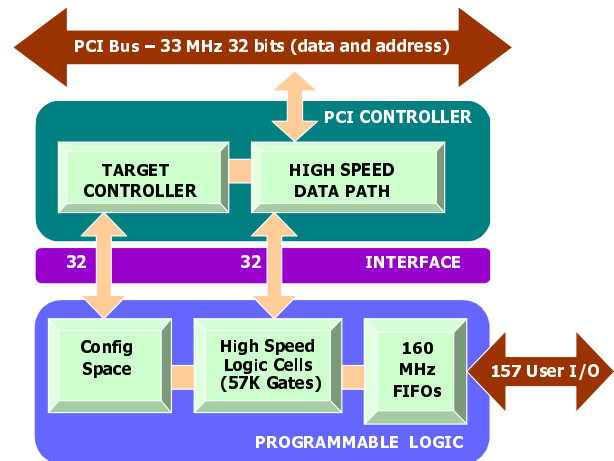
- 32-bit / 33 MHz PCI Target
- Zero-wait state PCI Target provides 132 MB/s transfer rates
- Programmable back-end interface to optional local processor
- Independent PCI bus (33 MHz) and local bus (up to 160 MHz) clocks
- Fully customizable PCI Configuration Space
- Configurable FIFOs with depths up to 128
- Reference design with driver code (Win 95/98/Win 2000/NT4.0) available
- PCI v2.2 compliant
- Supports Type 0 Configuration Cycles
- 3.3V, 5V Tolerant PCI signaling supports Universal PCI Adapter designs
- 3.3V CMOS in 144-pin TQFP, 208-pin PQFP and 256-PBGA
- Supports endian conversions
- Unlimited/Continuous Burst Transfers Supported

### Extendable PCI Functionality

- Support for Configuration Space from 0x40 to 0x3FF
- Multi-Function, Expanded Capabilities, & Expansion ROM capable
- Power management, Compact PCI, hot-swap/hot-plug compatible
- PCI v2.2 Power Management Spec compatible
- PCI v2.2 Vital Product Data (VPD) configuration support
- Programmable Interrupt Generator
- I<sub>2</sub>O support with local processor
- Mailbox register support

### Programmable Logic

- 57K System gates / 619 Logic Cells
- 13,824 RAM bits, up to 157 I/O pins
- 250 MHz 16-bit counters, 275 MHz Datapaths, 160 MHz FIFOs
- All back-end interface and glue-logic can be implemented on chip
- 6 64-deep FIFOs (2 RAMs each) or 3 128-deep FIFOs (4 RAMs each) or a combination that requires 12 or less QuickLogic RAM Modules
- (2) 32-bit busses interface between the PCI Controller and the Programmable Logic



**FIGURE 1. QL5130 Diagram**

## ARCHITECTURE OVERVIEW

The QL5130 device in the QuickLogic QuickPCI ESP (Embedded Standard Product) family provides a complete and customizable PCI interface solution combined with 57,000 System gates of programmable logic. This device eliminates any need for the designer to worry about PCI bus compliance, yet allows for the maximum 32-bit PCI bus bandwidth (132 MB/s).

The programmable logic portion of the device contains 619 QuickLogic Logic Cells, and 12 QuickLogic Dual-Port RAM Blocks. These configurable RAM blocks can be configured in many width/depth combinations. They can also be combined with logic cells to form FIFOs, or be initialized via Serial EEPROM on power-up and used as ROMs. See the RAM section of this data sheet for more information.

The QL5130 device meets PCI 2.2 electrical and timing specifications and has been fully hardware-tested. This device also supports the Win98 and PC98 standards. The QL5130 device features 3.3-volt operation with multi-volt compatible I/Os. Thus it can easily operate in 3.3-volt systems and is fully compatible with 3.3V, 5V and Universal PCI card development.



## PCI INTERFACE

The PCI target is PCI 2.2 compliant and supports 32-bit/33 MHz operation. It is capable of zero wait-state infinite-length read and write transactions (132 MBytes/second). Transaction control is available via the user interface as retries, wait-states, or premature transaction termination may be induced if necessary. The PCI configuration registers are implemented in the programmable region of the device, leaving the designer with ample flexibility to support optional features.

The QL5130 device supports maximum 32-bit PCI transfer rates, so many applications exist which are ideally suited to the device's high performance. High-speed data communications, telecommunications, and computing systems are just a few of the broad range of applications areas that can benefit from the high speed PCI interface and programmable logic.

## PCI CONFIGURATION SPACE

The QL5130 supports customization of required Configuration Registers such as Vendor ID, Device ID, Subsystem Vendor ID, etc.. QuickLogic provides a reference Configuration Space design block.

Since the PCI Configuration Registers are implemented in the programmable region of the QL5130, the designer can implement optional features such as multiple 32-bit Base Address Registers (BARs) and multiple functions, as well as support the following PCI commands: I/O Read, I/O Write, Memory Read, Memory Write, Config Read (required), Configuration Write (required), Memory Read Multiple, Memory Read Line, and Memory Write and Invalidate. Additionally, the device supports Extended Capabilities Registers, Expansion ROMs, power management, CompactPCI hot-plug/hot-swap, Vital Product Data, I<sub>2</sub>O, and mailbox registers.

## ADDRESS AND COMMAND DECODE

PCI address and command decoding is performed by logic in the programmable section of the device. This allows support for any size of memory or I/O space for back-end logic. It also allows the user to implement any subset of the PCI commands supported by the QL5130. QuickLogic provides a reference Address Register/Counter and Command Decode block.

## ARCHITECTURE OVERVIEW

The RAM modules in the programmable region can be used to create configurable 32-bit FIFOs. Each 32-bit FIFO can be independently assigned to Target address space for read pre-fetch or write posting. Using the 12 QuickLogic RAM modules, the combinations include:

- 6 independent 64-deep FIFO (2 RAMs each), or
- 3 independent 128-deep FIFOs (4 RAMs each), or
- a combination of the above that requires 12 or less QuickLogic RAM Modules

Asynchronous FIFOs (with independent read and write clocks) are also supported.

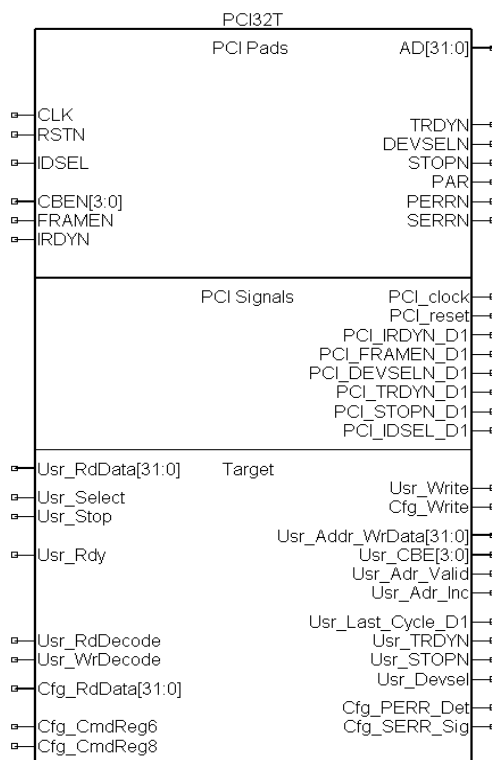


FIGURE 2. Graphical Interface to create FIFO

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## Internal PCI Interface

The symbol used to connect to the PCI interface of the QL5130 is shown below. This symbol is used in schematic or mixed schematic/HDL design flows in the QuickWorks software.



**FIGURE 3. PCI Interface Symbol**

## Internal Interface Signal Descriptions

Signals used to connect to the PCI interface in the QL5130 are described below. The direction of the signal indicates if it is an input provided by the local interface (I) or an output provided by the PCI interface (O).

Usr_Adr_WrData[31:0]	O	Target address, and data from target writes. During all target accesses, the address will be presented on Usr_Adr_WrData[31:0] and simultaneously, Usr_Adr_Valid will be active. During target write transactions, this port will also present write data to the PCI configuration space or user logic.
Usr_CBE[3:0]	O	PCI command and byte enables. During target accesses, the PCI command will be presented on Usr_CBE[3:0] and simultaneously, Usr_Adr_Valid will be active. During target read or write transactions, this port will present active-low byte-enables to the PCI configuration space or user logic.
Usr_Adr_Valid	O	Indicates the beginning of a PCI transaction, and that a target address is valid on Usr_Adr_WrData[31:0] and the PCI command is valid on Usr_CBE[3:0]. When this signal is active, the target address must be latched and decoded to determine if this address belongs to the device's memory space. Also, the PCI command must be decoded to determine the type of PCI transaction. On subsequent clocks of a target access, this signal will be low, indicating that an address is NOT present on Usr_Adr_WrData[31:0].
Usr_Adr_Inc	O	Indicates that the target address should be incremented, because the previous data transfer has completed. During burst target accesses, the target address is only presented to the back-end logic at the beginning of the transaction (when Usr_Adr_Valid is active), and must therefore be latched and incremented (by 4) for subsequent data transfers. Note that during write transactions, Usr_Adr_Inc indicates valid data on Usr_Adr_WrData[31:0] that must be accepted by the back-end logic (regardless of the state of Usr_Rdy). During read transactions, Usr_Adr_Inc will signal to the back-end that the PCI core is ready to accept data. Usr_Adr_Inc and Usr_Rdy both active during a read transaction signals a data transfer between the FPGA and the PCI core (and that the address counter must be incremented).
Usr_RdDecode	I	This signal should be driven active when a "user read" command has been decoded from the Usr_CBE[3:0] bus (while Usr_Adr_Valid is active). This command may be mapped from any of the PCI "read" commands, such as Memory Read, Memory Read Line, Memory Read Multiple, I/O Read, etc.
Usr_WrDecode	I	This signal should be driven active when a "user write" command has been decoded from the Usr_CBE[3:0] bus (while Usr_Adr_Valid is active). This command may be mapped from any of the PCI "write" commands, such as Memory Write or I/O Write.

## Internal Interface Signal Descriptions (Continued)

Usr_Select	I	This signal should be driven active when the address on Usr_Addr_WrData[31:0] has been decoded and determined to be within the address space of the device. Usr_Addr_WrData[31:0] must be compared to each of the valid Base Address Registers in the PCI configuration space. Also, this signal must be gated by the Memory Access Enable or I/O Access Enable registers in the PCI configuration space (Command Register bits 1 or 0 at offset 04h).
Usr_Write	O	This signal will be active throughout a “user write” transaction, which has been decoded by Usr_WrDecode at the beginning of the transaction. The write-enable for individual double-words of data (on Usr_Addr_WrData[31:0]) during a user write transaction should be generated by logically ANDing this signal with Usr_Adr_Inc.
Cfg_Write	O	This signal will be active throughout a configuration write transaction. The write-enable for individual double-words of data (on Usr_Addr_WrData[31:0]) during a configuration write transaction should be generated by logically ANDing this signal with Usr_Adr_Inc.
Cfg_RdData[31:0]	I	Data from the PCI configuration registers, required to be presented to the PCI core during PCI configuration reads.
Usr_RdData[31:0]	I	Data from the back-end user logic, required to be presented during PCI reads.
Cfg_CmdReg8 Cfg_CmdReg6	I	Bits 6 and 8 from the Command Register in the PCI configuration space (offset 04h).
Cfg_PERR_Det	O	Parity error detected on the PCI bus. When this signal is active, bit 15 of the Status Register must be set in the PCI configuration space (offset 04h).
Cfg_SERR_Sig	O	System error asserted on the PCI bus. When this signal is active, the Signaled System Error bit, bit 14 of the Status Register, must be set in the PCI configuration space (offset 04h).
Usr_TRDYN	O	Copy of the TRDYN signal as driven by the PCI target interface.
Usr_STOPN	O	Copy of the STOPN signal as driven by the PCI target interface.
Usr_Devsel	O	Inverted copy of the DEVSELN signal as driven by the PCI target interface.
Usr_Last_Cycle_D1	O	Indicates that the last transfer in a PCI transaction is occurring.
RdPipe_Stat[1:0]	O	Indicates the number of dwords currently in the read pipeline (“00” = 0 elements, “01” = 1 element, “11” = 2 elements). This value is important at the end of a transaction (i.e. when Usr_Last_Cycle_D1 is active) if non-prefetchable memory is being read. Non-prefetchable memory is defined as registers or memory elements whose value changes when they are read. Examples are status registers which are cleared when they are read, or FIFO memories, since consecutive reads from the same address in these elements may not produce the same data values.
Usr_Rdy	I	Used to delay (add wait states to) a PCI transaction when the back end needs additional time. Subject to PCI latency restrictions.
Usr_Stop	I	Used to prematurely stop a PCI target access on the next PCI clock.

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## ARRAY OF LOGIC CELLS

A wide range of additional features complements the QL5130 device. The FPGA portion of the device is 5 volt and 3.3-volt PCI-compliant and can perform high-speed logic functions such as 160 MHz FIFOs. I/O pins provide individually controlled output enables, dedicated input/feedback registers, and full JTAG capability for boundary scan and test. In addition, the QL5130 device provides the benefits of non-volatility, high design security, immediate functionality on power-up, and a single chip solution.

The QL5130 programmable logic architecture consists of an array of user-configurable logic building blocks, called logic cells, set beneath a grid of metal wiring channels similar to those of a gate array. Through ViaLink® elements located at the wire intersections, the output(s) of any cell may be programmed to connect to the input(s) of any other cell. Using the programmable logic in the QL5130, designers can quickly and easily customize their “back-end” design for any number of applications.

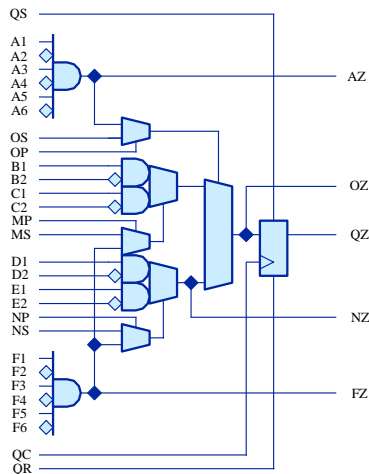


FIGURE 4. Logic Cell

## RAM MODULE FEATURES

The QL5130 device has twelve 1,152-bit RAM modules, for a total of 13,824 RAM bits. Using two “mode” pins, designers can configure each module into 64 (deep) x18 (wide), 128x9, 256x4, or 512x2 blocks. See the figure below. The blocks are also easily cascadable to increase their effective width or depth.

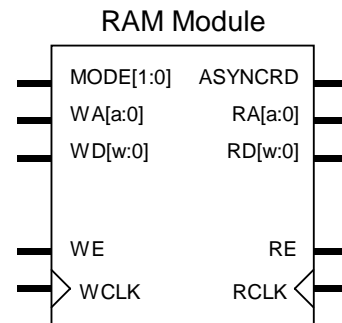


FIGURE 5. RAM Module

Mode:	Address Buses [a:0]	Data Buses [w:0]
<b>64x18</b>	[5:0]	[17:0]
<b>128x9</b>	[6:0]	[8:0]
<b>256x4</b>	[7:0]	[3:0]
<b>512x2</b>	[8:0]	[1:0]

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The RAM modules are “dual-ported”, with completely independent READ and WRITE ports and separate READ and WRITE clocks. The READ ports support asynchronous and synchronous operation, while the WRITE ports support synchronous operation. Each port has 18 data lines and 9 address lines, allowing word lengths of up to 18 bits and address spaces of up to 512 words. Depending on the mode selected, however, some higher order data or address lines may not be used.

The Write Enable (WE) line acts as a clock enable for synchronous write operation. The Read Enable (RE) acts as a clock enable for synchronous READ operation (ASYNCRD input low), or as a flow-through enable for asynchronous READ operation (ASYNCRD input high).

Designers can cascade multiple RAM modules to increase the depth or width allowed in single modules by connecting corresponding address lines together and dividing the words between modules. This approach allows up to 512-deep configurations as large as 28 bits wide in the QL5130 device.

A similar technique can be used to create depths greater than 512 words. In this case, address signals higher than the eighth bit are encoded onto the write enable (WE) input for WRITE operations. The READ data outputs are multiplexed together using encoded higher READ address bits for the multiplexer SELECT signals.

## JTAG SUPPORT

JTAG pins support IEEE standard 1149.1a to provide boundary scan capability for the QL5130 device. Six pins are dedicated to JTAG and programming functions on each QL5130 device, and are unavailable for general design input and output signals. TDI, TDO, TCK, TMS, and TRSTB are JTAG pins. A sixth pin, STM, is used only for programming.

## DEVELOPMENT TOOLS

Software support for the QL5130 device is available through the QuickWorks™ development package. This turnkey PC-based QuickWorks package, shown in Figure 6, provides a complete ESP software solution with design entry, logic synthesis, place and route, and simulation. QuickWorks includes VHDL, Verilog, schematic, and mixed-mode entry with fast and efficient logic synthesis provided by the integrated Synplicity Synplify Lite™ tool, specially tuned to take advantage of the QL5130 architecture. QuickWorks also provides functional and timing simulation for guaranteed timing and source-level debugging.

The UNIX-based QuickTools™ and PC-based QuickWorks-Lite™ packages are a subset of QuickWorks and provide a solution for designers who use schematic-only design flow third-party tools for design entry, synthesis, or simulation. QuickTools and QuickWorks-Lite read EDIF netlists and provide support for all QuickLogic devices. QuickTools and QuickWorks-Lite also support a wide range of third-party modeling and simulation tools. In addition, the PC-based package combines all the features of QuickWorks-Lite with the SCS schematic capture environment, providing a low-cost design entry and compilation solution.

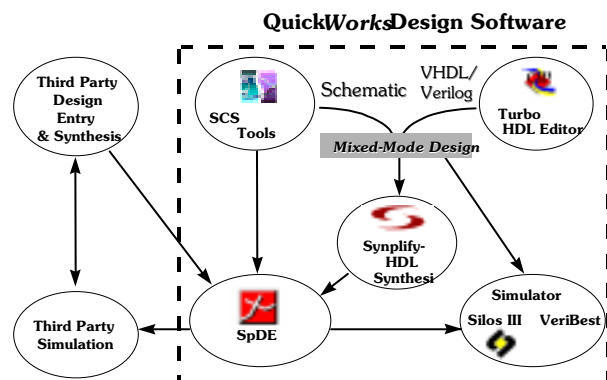


FIGURE 6. QuickWorks Tool Suite



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## QL5130 EXTERNAL DEVICE PINS

The QL5130 Device Pins are indicated in the table below. These are pins on the device, some of which connect to the PCI bus, and others that are programmable as user IO.

Type	Description	Pin/Bus Name	Type	Function
<b>IN</b>	Input. A standard input-only signal	<b>VCC</b>	IN	Supply pin. Tie to 3.3V supply.
<b>OUT</b>	Totem pole output. A standard active output driver	<b>VCCIO</b>	IN	Supply pin for I/O. Set to 3.3V for 3.3V I/O, 5V for 5.0V compliant I/O
<b>T/S</b>	Tri-state. A bi-directional, tri-state input/output pin	<b>GND</b>	IN	Ground pin. Tie to GND on the PCB.
<b>S/T/S</b>	Sustained Tri-state. An active low tri-state signal driven by one PCI agent at a time. It must be driven high for at least one clock before being disabled (set to Hi-Z). A pull-up needs to be provided by the PCI system central resource to sustain the inactive state once the active driver has released the signal.	<b>I/O</b>	T/S	Programmable Input/Output/Tri-State/Bi-directional Pin.
<b>O/D</b>	Open Drain. Allows multiple devices to share this pin as a wired-or.	<b>GLCK/I</b>	IN	Programmable Global Network or Input-only pin. Tie to VCC or GND if unused.
		<b>ACLK/I</b>	IN	Programmable Array Network or Input-only pin. Tie to VCC or GND if unused.
		<b>TDI/RSI*</b>	IN	JTAG Data In/Ram Init. Serial Data In. Tie to VCC if unused. Connect to Serial EPROM data for RAM init.
		<b>TDO/RCO*</b>	OUT	JTAG Data Out/Ram Init Clock. Leave unconnected if unused. Connect to Serial EPROM clock for RAM init.
		<b>TCK</b>	IN	JTAG Clock. Tie to GND if unused.
		<b>TMS</b>	IN	JTAG Test Mode Select. Tie to VCC if unused.
		<b>TRSTB/RRO*</b>	IN	JTAG Reset/RAM Init. Reset Out. Tie to GND if unused. Connect to Serial EPROM reset for RAM init.
		<b>STM</b>	IN	QuickLogic Reserved pin. Tie to GND on the PCB.

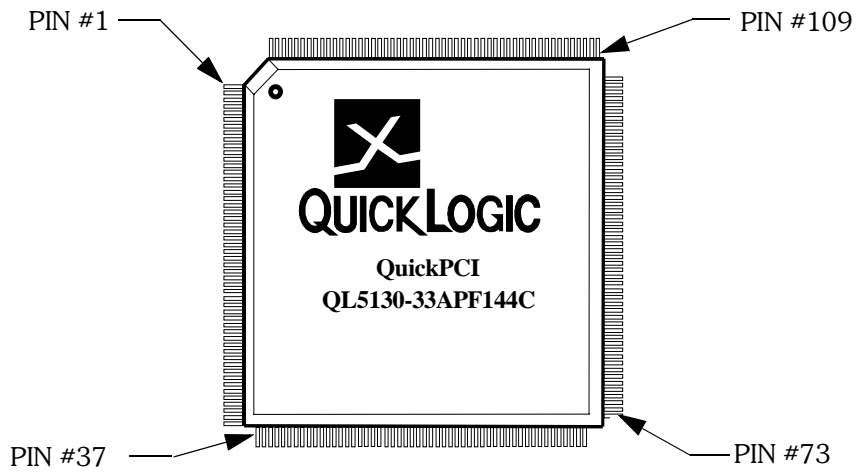
\* See QuickNote 65 on the QuickLogic web site for information on RAM initialization.



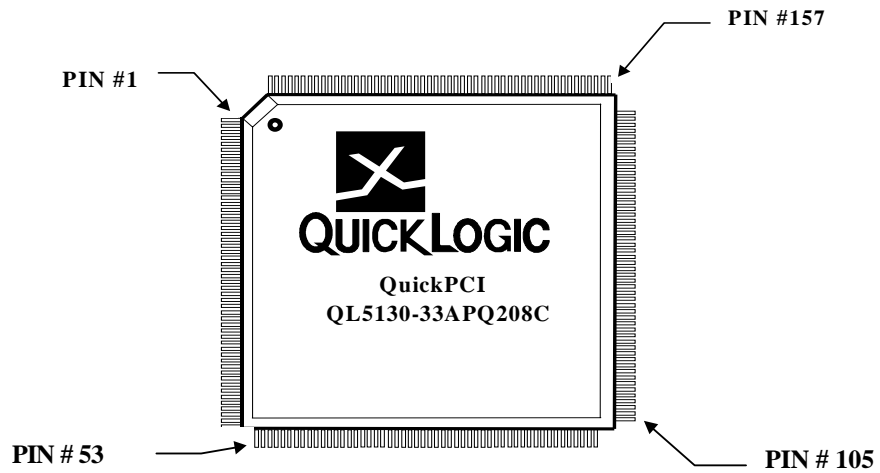
## EXTERNAL DEVICE PINS

Pin/Bus Name	Type	Function
<b>AD[31:0]</b>	<b>T/S</b>	PCI Address and Data: 32 bit multiplexed address/data bus.
<b>CBEN[3:0]</b>	<b>T/S</b>	PCI Bus Command and Byte Enables: Multiplexed bus which contains byte enables for AD[31:0] or the Bus Command during the address phase of a PCI transaction.
<b>PAR</b>	<b>T/S</b>	PCI Parity: Even Parity across AD[31:0] and C/BEN[3:0] busses. Driven one clock after address or data phases. Master drives PAR on address cycles and PCI writes. The Target drives PAR on PCI reads.
<b>FRAMEN</b>	<b>S/T/S</b>	PCI Cycle Frame: Driven active by current PCI Master during a PCI transaction. Driven low to indicate the address cycle, driven high at the end of the transaction.
<b>DEVSELN</b>	<b>S/T/S</b>	PCI Device Select. Driven by a Target that has decoded a valid base address.
<b>CLK</b>	<b>IN</b>	PCI System Clock Input.
<b>RSTN</b>	<b>IN</b>	PCI System Reset Input
<b>PERRN</b>	<b>S/T/S</b>	PCI Data Parity Error. Driven active by the initiator or target two clock cycles after a data parity error is detected on the AD and C/BEN busses.
<b>SERRN</b>	<b>O/D</b>	PCI System Error: Driven active when an address cycle parity error, data parity error during a special cycle, or other catastrophic error is detected.
<b>IDSEL</b>	<b>IN</b>	PCI Initialization Device Select. Use to select a specific PCI Agent during System Initialization.
<b>IRDYN</b>	<b>S/T/S</b>	PCI Initiator Ready. Indicates the Initiator's ability to complete a read or write transaction. Data transfer occurs only on clock cycles where both IRDYN and TRDYN are active.
<b>TRDYN</b>	<b>S/T/S</b>	PCI Target Ready. Indicates the Target's ability to complete a read or write transaction. Data transfer occurs only on clock cycles where both IRDYN and TRDYN are active.
<b>STOPN</b>	<b>S/T/S</b>	PCI Stop. Used by a PCI Target to end a burst transaction.

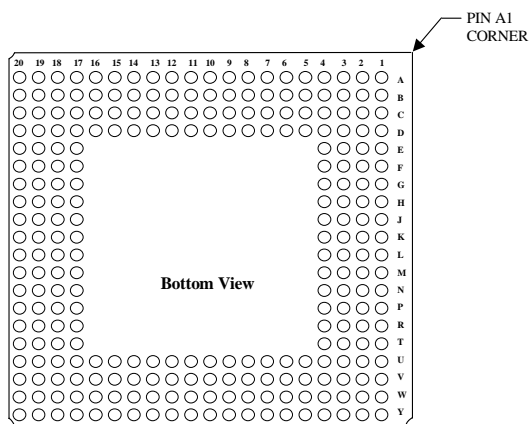
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**FIGURE 7. 144-pin TQFP**



**FIGURE 8. 208-pin PQFP**



**FIGURE 9. 256-pin PBGA**

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## QL5130 - 144 TQFP PINOUT

PF144	Function	PF144	Function	PF144	Function	PF144	Function
1	I/O	37	AD[21]	73	AD[4]	109	<b>TCK</b>
2	I/O	38	<b>TDI/RSI</b>	74	AD[3]	110	<b>STM</b>
3	I/O	39	AD[20]	75	AD[2]	111	I/O
4	I/O	40	AD[19]	76	AD[1]	112	I/O
5	I/O	41	AD[18]	77	AD[0]	113	I/O
6	I/O	42	<b>VCC</b>	78	I/O	114	<b>VCC</b>
7	<b>VCC</b>	43	AD[17]	79	<b>VCC</b>	115	I/O
8	I/O	44	AD[16]	80	I/O	116	I/O
9	I/O	45	CBEN[2]	81	I/O	117	I/O
10	I/O	46	FRAMEN	82	I/O	118	I/O
11	I/O	47	IRDYN	83	I/O	119	I/O
12	I/O	48	TRDYN	84	I/O	120	I/O
13	I/O	49	DEVSELN	85	I/O	121	I/O
14	I/O	50	<b>GND</b>	86	I/O	122	<b>GND</b>
15	<b>GND</b>	51	STOPN	87	<b>GND</b>	123	I/O
16	I/O	52	PERRN	88	I/O	124	I/O
17	GCLK/I	53	SERRN	89	GCLK/I	125	I/O
18	ACLK/I	54	<b>GND</b>	90	ACLK/I	126	<b>GND</b>
19	<b>VCC</b>	55	PAR	91	<b>VCC</b>	127	I/O
20	RSTN	56	CBEN[1]	92	GCLK/I	128	I/O
21	CLK	57	AD[15]	93	GCLK/I	129	I/O
22	<b>VCC</b>	58	<b>VCCIO</b>	94	<b>VCC</b>	130	<b>VCCIO</b>
23	I/O	59	AD[14]	95	I/O	131	I/O
24	AD[31]	60	AD[13]	96	I/O	132	I/O
25	AD[30]	61	AD[12]	97	I/O	133	I/O
26	AD[29]	62	AD[11]	98	I/O	134	I/O
27	AD[28]	63	AD[10]	99	I/O	135	I/O
28	AD[27]	64	AD[9]	100	I/O	136	I/O
29	AD[26]	65	AD[8]	101	I/O	137	I/O
30	<b>GND</b>	66	<b>GND</b>	102	<b>GND</b>	138	<b>GND</b>
31	AD[25]	67	CBEN[0]	103	I/O	139	I/O
32	AD[24]	68	AD[7]	104	I/O	140	I/O
33	CBEN[3]	69	AD[6]	105	I/O	141	I/O
34	IDSEL	70	AD[5]	106	I/O	142	I/O
35	AD[23]	71	<b>TRSTB/RRO</b>	107	I/O	143	<b>TDO/RCO</b>
36	AD[22]	72	<b>TMS</b>	108	I/O	144	I/O

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## QL5130 - 208 PQFP PINOUT

PO208	Function	PO20	Function	PO208	Function	PO208	Function	PO208	Function
1	I/O	43	GND	85	AD[3]	127	GND	169	I/O
2	I/O	44	IDSEL	86	AD[2]	128	I/O	170	I/O
3	I/O	45	AD[23]	87	AD[1]	129	GCLK/I	171	I/O
4	I/O	46	AD[22]	88	AD[0]	130	ACLK/I	172	I/O
5	I/O	47	AD[21]	89	I/O	131	VCC	173	I/O
6	I/O	48	AD[20]	90	I/O	132	GCLK/I	174	I/O
7	I/O	49	AD[19]	91	I/O	133	GCLK/I	175	I/O
8	I/O	50	AD[18]	92	I/O	134	VCC	176	I/O
9	I/O	51	AD[17]	93	I/O	135	I/O	177	GND
10	VCC	52	AD[16]	94	I/O	136	I/O	178	I/O
11	I/O	53	CBEN[2]	95	GND	137	I/O	179	I/O
12	GND	54	TDI	96	I/O	138	I/O	180	I/O
13	I/O	55	FRAMEN	97	VCC	139	I/O	181	I/O
14	I/O	56	IRDYN	98	I/O	140	I/O	182	GND
15	I/O	57	TRDYN	99	I/O	141	I/O	183	I/O
16	I/O	58	DEVSELN	100	I/O	142	I/O	184	I/O
17	I/O	59	GND	101	I/O	143	I/O	185	I/O
18	I/O	60	STOPN	102	I/O	144	I/O	186	I/O
19	I/O	61	VCC	103	TRSTB	145	VCC	187	VCCIO
20	I/O	62	I/O	104	TMS	146	I/O	188	I/O
21	I/O	63	I/O	105	I/O	147	GND	189	I/O
22	I/O	64	PERRN	106	I/O	148	I/O	190	I/O
23	GND	65	I/O	107	I/O	149	I/O	191	I/O
24	I/O	66	SERRN	108	I/O	150	I/O	192	I/O
25	RSTN	67	PAR	109	I/O	151	I/O	193	I/O
26	ACLK/I	68	CBEN[1]	110	I/O	152	I/O	194	I/O
27	VCC	69	AD[15]	111	I/O	153	I/O	195	I/O
28	GCLK/I	70	AD[14]	112	I/O	154	I/O	196	I/O
29	CLK	71	AD[13]	113	I/O	155	I/O	197	I/O
30	VCC	72	AD[12]	114	VCC	156	I/O	198	I/O
31	I/O	73	GND	115	I/O	157	TCK	199	GND
32	I/O	74	AD[11]	116	GND	158	STM	200	I/O
33	AD[31]	75	AD[10]	117	I/O	159	I/O	201	VCC
34	AD[30]	76	AD[9]	118	I/O	160	I/O	202	I/O
35	AD[29]	77	AD[8]	119	I/O	161	I/O	203	I/O
36	AD[28]	78	GND	120	I/O	162	I/O	204	I/O
37	AD[27]	79	CBEN[0]	121	I/O	163	GND	205	I/O
38	AD[26]	80	AD[7]	122	I/O	164	I/O	206	I/O
39	AD[25]	81	AD[6]	123	I/O	165	VCC	207	TDO
40	AD[24]	82	AD[5]	124	I/O	166	I/O	208	I/O
41	VCC	83	VCCIO	125	I/O	167	I/O		
42	CBEN[3]	84	AD[4]	126	I/O	168	I/O		

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## QL5130 - 256 PBGA PINOUT

PB256	Function	PB256	Function	PB256	Function	PB256	Function	PB256	Function	PB256	Function
A1	GND	C4	I/O	E19	I/O	L2	ACLK/1	T17	I/O	V20	I/O
A2	I/O	C5	I/O	E20	I/O	L3	RSTN	T18	I/O	W1	I/O
A3	I/O	C6	I/O	F1	I/O	L4	GCLK/1	T19	NC	W2	I/O
A4	I/O	C7	I/O	F2	I/O	L17	VCC	T20	I/O	W3	TDI
A5	I/O	C8	I/O	F3	I/O	L18	I/O	U1	I/O	W4	I/O
A6	I/O	C9	VCCIO	F4	VCC	L19	I/O	U2	I/O	W5	AD[27]
A7	I/O	C10	I/O	F17	VCC	L20	I/O	U3	I/O	W6	CBEN[3]
A8	I/O	C11	I/O	F18	NC	M1	I/O	U4	GND	W7	AD[21]
A9	I/O	C12	I/O	F19	I/O	M2	I/O	U5	AD[26]	W8	AD[20]
A10	I/O	C13	I/O	F20	I/O	M3	I/O	U6	VCC	W9	CBEN[2]
A11	I/O	C14	I/O	G1	I/O	M4	NC	U7	AD[22]	W10	DEVSELN
A12	I/O	C15	I/O	G2	NC	M17	NC	U8	GND	W11	PERRN
A13	I/O	C16	I/O	G3	I/O	M18	I/O	U9	FRAMEN	W12	CBEN[1]
A14	I/O	C17	I/O	G4	I/O	M19	I/O	U10	VCC	W13	PAR
A15	I/O	C18	I/O	G17	I/O	M20	I/O	U11	I/O	W14	AD[10]
A16	I/O	C19	I/O	G18	I/O	N1	I/O	U12	I/O	W15	AD[9]
A17	I/O	C20	I/O	G19	NC	N2	I/O	U13	GND	W16	AD[5]
A18	I/O	D1	I/O	G20	I/O	N3	I/O	U14	AD[11]	W17	AD[1]
A19	TCK	D2	I/O	H1	I/O	N4	GND	U15	VCC	W18	AD[0]
A20	I/O	D3	I/O	H2	I/O	N17	GND	U16	AD[4]	W19	I/O
B1	TDO	D4	GND	H3	I/O	N18	I/O	U17	GND	W20	TRSTB
B2	I/O	D5	I/O	H4	GND	N19	I/O	U18	I/O	Y1	I/O
B3	I/O	D6	VCC	H17	GND	N20	I/O	U19	I/O	Y2	NC
B4	I/O	D7	I/O	H18	I/O	P1	I/O	U20	I/O	Y3	I/O
B5	I/O	D8	GND	H19	I/O	P2	I/O	V1	I/O	Y4	AD[31]
B6	I/O	D9	I/O	H20	I/O	P3	I/O	V2	NC	Y5	AD[29]
B7	I/O	D10	I/O	J1	I/O	P4	I/O	V3	I/O	Y6	AD[25]
B8	I/O	D11	VCC	J2	I/O	P17	I/O	V4	AD[30]	Y7	AD[23]
B9	I/O	D12	I/O	J3	NC	P18	I/O	V5	AD[28]	Y8	AD[19]
B10	I/O	D13	GND	J4	I/O	P19	NC	V6	AD[24]	Y9	AD[17]
B11	I/O	D14	I/O	J17	NC	P20	I/O	V7	IDSEL	Y10	IRDYN
B12	I/O	D15	VCC	J18	I/O	R1	NC	V8	AD[18]	Y11	I/O
B13	I/O	D16	I/O	J19	I/O	R2	I/O	V9	AD[16]	Y12	SERRN
B14	I/O	D17	GND	J20	GCLK/1	R3	I/O	V10	TRDYN	Y13	AD[14]
B15	I/O	D18	I/O	K1	I/O	R4	VCC	V11	STOPN	Y14	AD[12]
B16	I/O	D19	I/O	K2	I/O	R17	VCC	V12	VCCIO	Y15	AD[8]
B17	NC	D20	I/O	K3	I/O	R18	I/O	V13	AD[15]	Y16	AD[7]
B18	STM	E1	NC	K4	VCC	R19	I/O	V14	AD[13]	Y17	AD[3]
B19	NC	E2	I/O	K17	GCLK/1	R20	I/O	V15	CBEN[0]	Y18	I/O
B20	I/O	E3	I/O	K18	ACLK/1	T1	NC	V16	AD[6]	Y19	I/O
C1	I/O	E4	I/O	K19	GCLK/1	T2	I/O	V17	AD[2]	Y20	NC
C2	I/O	E17	I/O	K20	NC	T3	I/O	V18	I/O		
C3	I/O	E18	I/O	L1	CLK	T4	NC	V19	TMS		

# QL5130 - QuickPCI™

## Absolute Maximum Ratings

VCC Voltage .....	-0.5 to 4.6V	DC Input Current.....	±20 mA
VCCIO Voltage.....	-0.5 to 7.0V	ESD Pad Protection.....	±2000V
Input Voltage .....	-0.5 to VCCIO+0.5V	Storage Temperature .....	-65°C to +150C
Latch-up Immunity .....	±200mA	Lead Temperature .....	300°C

## Operating Range

Symbol	Parameter	Industrial		Commercial		Unit
		Min	Max	Min	Max	
VCC	Supply Voltage	3.0	3.6	3.0	3.6	V
VCCIO	I/O Input Tolerance Voltage	3.0	5.5	3.0	5.25	V
TA	Ambient Temperature	-40	85	0	70	°C
K	Delay Factor	-A Speed Grade	0.43	0.90	0.46	0.88

## DC Characteristics

Symbol	Parameter	Conditions	Min	Max	Unit
VIH	Input HIGH Voltage		0.5VCC	VCCIO+0.5	V
VIL	Input LOW Voltage		-0.5	0.3VCC	V
VOH	Output HIGH Voltage	IOH = -12 mA	2.4		V
		IOH = -500 µA	0.9VCC		V
VOL	Output LOW Voltage	IOL = 16 mA		0.45	V
		IOL = 1.5 mA		0.1VCC	V
II	I or I/O Input Leakage Current	VI = VCCIO or GND	-10	10	µA
IOZ	3-State Output Leakage Current	VI = VCCIO or GND	-10	10	µA
CI	Input Capacitance [1]			10	pF
IOS	Output Short Circuit Current [2]	VO = GND	-15	-180	mA
		VO = VCC	40	210	mA
ICC	D.C. Supply Current [3]	VI, VIO = VCCIO or GND	0.50 (typ)	2	mA
ICCIO	D.C. Supply Current on VCCIO		0	100	µA

- [1] Capacitance is sample tested only. Clock pins are 12 pF maximum.
- [2] Only one output at a time. Duration should not exceed 30 seconds.
- [3] For -A commercial grade device only. Maximum ICC is 3 mA for all industrial grade devices. For AC conditions, contact QuickLogic Customer Engineering.

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## AC CHARACTERISTICS at VCC = 3.3V, TA = 25°C (K = 1.00)

(To calculate delays, multiply the appropriate K factor in the “Operating Range” section by the following numbers.)

### Logic Cells

Symbol	Parameter	Propagation Delays (ns)				
		Fanout [5]				
		1	2	3	4	8
tPD	Combinatorial Delay [6]	1.4	1.7	1.9	2.2	3.2
tSU	Setup Time [6]	1.7	1.7	1.7	1.7	1.7
tH	Hold Time	0.0	0.0	0.0	0.0	0.0
tCLK	Clock to Q Delay	0.7	1.0	1.2	1.5	2.5
tCWHI	Clock High Time	1.2	1.2	1.2	1.2	1.2
tCWLO	Clock Low Time	1.2	1.2	1.2	1.2	1.2
tSET	Set Delay	1.0	1.3	1.5	1.8	2.8
tRESET	Reset Delay	0.8	1.1	1.3	1.6	2.6
tSW	Set Width	1.9	1.9	1.9	1.9	1.9
tRW	Reset Width	1.8	1.8	1.8	1.8	1.8

### RAM Cell Synchronous Write Timing

Symbol	Parameter	Propagation Delays (ns)				
		Fanout				
		1	2	3	4	8
TSWA	WA Setup Time to WCLK	1.0	1.0	1.0	1.0	1.0
THWA	WA Hold Time to WCLK	0.0	0.0	0.0	0.0	0.0
TSWD	WD Setup Time to WCLK	1.0	1.0	1.0	1.0	1.0
THWD	WD Hold Time to WCLK	0.0	0.0	0.0	0.0	0.0
TSWE	WE Setup Time to WCLK	1.0	1.0	1.0	1.0	1.0
THWE	WE Hold Time to WCLK	0.0	0.0	0.0	0.0	0.0
TWCRD	WCLK to RD (WA=RA) [4]	5.0	5.3	5.6	5.9	7.1

Notes:

- [4] Stated timing for worst case Propagation Delay over process variation at VCC=3.3V and TA=25°C. Multiply by the appropriate Delay Factor, K, for speed grade, voltage and temperature settings as specified in the Operating Range.
- [5] These limits are derived from a representative selection of the slowest paths through the QuickRAM logic cell including typical net delays. Worst case delay values for specific paths should be determined from timing analysis of your particular design.



## RAM Cell Synchronous Read Timing

Symbol	Parameter	Propagation Delays (ns) Fanout				
		1	2	3	4	8
TSRA	RA Setup Time to RCLK	1.0	1.0	1.0	1.0	1.0
THRA	RA Hold Time to RCLK	0.0	0.0	0.0	0.0	0.0
TSRE	RE Setup Time to RCLK	1.0	1.0	1.0	1.0	1.0
THRE	RE Hold Time to RCLK	0.0	0.0	0.0	0.0	0.0
TRCRD	RCLK to RD [4]	4.0	4.3	4.6	4.9	6.1

## RAM Cell Asynchronous Read Timing

Symbol	Parameter	Propagation Delays (ns) Fanout				
		1	2	3	4	8
RPDRD	RA to RD [4]	3.0	3.3	3.6	3.9	5.1

## Input-Only Cells

Symbol	Parameter	Propagation Delays (ns) Fanout [5]						
		1	2	3	4	8	12	24
TIN	High Drive Input Delay	1.5	1.6	1.8	1.9	2.4	2.9	4.4
TINI	High Drive Input, Inverting Delay	1.6	1.7	1.9	2.0	2.5	3.0	4.5
TISU	Input Register Set-Up Time	3.1	3.1	3.1	3.1	3.1	3.1	3.1
TIH	Input Register Hold Time	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TICLK	Input Register Clock To Q	0.7	0.8	1.0	1.1	1.6	2.1	3.6
TIRST	Input Register Reset Delay	0.6	0.7	0.9	1.0	1.5	2.0	3.5
TIESU	Input Register Clock Enable Setup Time	2.3	2.3	2.3	2.3	2.3	2.3	2.3
TIEH	Input Register Clock Enable Hold Time	0.0	0.0	0.0	0.0	0.0	0.0	0.0

## Clock Cells

Symbol	Parameter	Propagation Delays (ns) Loads per Half Column [7]						
		1	2	3	4	8	10	11
tACK	Array Clock Delay	1.2	1.2	1.3	1.3	1.5	1.6	1.7
tGCKP	Global Clock Pin Delay	0.7	0.7	0.7	0.7	0.7	0.7	0.7
tGCKB	Global Clock Buffer Delay	0.8	0.8	0.9	0.9	1.1	1.2	1.3

Notes:

- [6] The array distributed networks consist of 40 half columns and the global distributed networks consist of 44 half columns, each driven by an independent buffer. The number of half columns used does not affect clock buffer delay. The array clock has up to 8 loads per half column. The global clock has up to 11 loads per half column.

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## I/O Cell Input Delays

Symbol	Parameter	Propagation Delays (ns) Fanout [5]					
		1	2	3	4	8	10
tI/O	Input Delay (bidirectional pad)	1.3	1.6	1.8	2.1	3.1	3.6
TISU	Input Register Set-Up Time	3.1	3.1	3.1	3.1	3.1	3.1
TIH	Input Register Hold Time	0.0	0.0	0.0	0.0	0.0	0.0
TIOCLK	Input Register Clock To Q	0.7	1.0	1.2	1.5	2.5	3.0
TIORST	Input Register Reset Delay	0.6	0.9	1.1	1.4	2.4	2.9
TIESU	Input Register clock Enable Set-Up Time	2.3	2.3	2.3	2.3	2.3	2.3
TIEH	Input Register Clock Enable Hold Time	0.0	0.0	0.0	0.0	0.0	0.0

## I/O Cell Output Delays

Symbol	Parameter	Propagation Delays (ns) Output Load Capacitance (pF)				
		30	50	75	100	150
TOUTLH	Output Delay Low to High	2.1	2.5	3.1	3.6	4.7
TOUTHHL	Output Delay High to Low	2.2	2.6	3.2	3.7	4.8
TPZH	Output Delay Tri-state to High	1.2	1.7	2.2	2.8	3.9
TPZL	Output Delay Tri-state to Low	1.6	2.0	2.6	3.1	4.2
TPHZ	Output Delay High to Tri-State [8]	2.0				
TPLZ	Output Delay Low to Tri-State [8]	1.2				

Notes:

[7] The following loads are used for tPXZ:

