

# QL4058 - QuickRAM™



58,000 Usable PLD Gate QuickRAM ESP Combining Performance, Density, and Embedded RAM

## DEVICE HIGHLIGHTS

### High Performance & High Density

- 58,000 Usable PLD Gates with 252 I/Os
- 300 MHz 16-bit Counters, 400 MHz Datapaths, 160+ MHz FIFOs
- 0.35µm four-layer metal non-volatile CMOS process for smallest die sizes

### High Speed Embedded SRAM

- 18 dual-port RAM modules, organized in user-configurable 1,152 bit blocks
- 5ns access times, each port independently accessible
- Fast and efficient for FIFO, RAM, and ROM functions

### Easy to Use / Fast Development Cycles

- 100% routable with 100% utilization and complete pin-out stability
- Variable-grain logic cells provide high performance and 100% utilization
- Comprehensive design tools include high quality Verilog/VHDL synthesis

### Advanced I/O Capabilities

- Interfaces with both 3.3 volt and 5.0 volt devices
- PCI compliant with 3.3V and 5.0V busses for -1/-2/-3/-4 speed grades
- Full JTAG boundary scan
- Registered I/O cells with individually controlled clocks and output enables

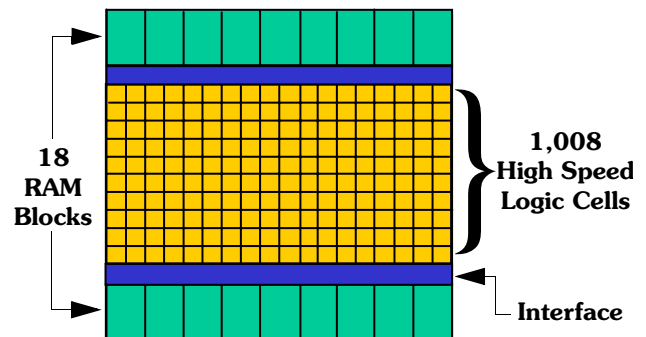


FIGURE 1. QuickRAM Block Diagram

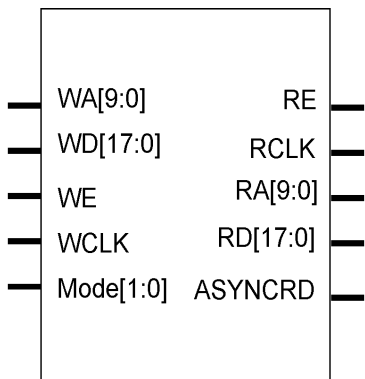
## ARCHITECTURE OVERVIEW

The QuickRAM family of ESPs (Embedded Standard Products) offers FPGA logic in combination with Dual-Port SRAM modules. The QL4058 is a 58,000 usable PLD gate member of the QuickRAM family of ESPs. QuickRAM ESPs are fabricated on a 0.35µm four-layer metal process using QuickLogic's patented ViaLink™ technology to provide a unique combination of high performance, high density, low cost, and extreme ease-of-use.

The QL4058 contains 1,008 logic cells and 18 dual port RAM modules (see Figure 1). Each RAM module has 1,152 RAM bits, for a total of 20,736 bits. RAM Modules are Dual Port (one read port, one write port) and can be configured into one of four modes: 64 (deep) x18 (wide), 128x9, 256x4, or 512x2 (see Figure 2). With a maximum of 204 I/Os, the QL4058 is available in 208-pin PQFP, 240-pin PQFP and 456-pin PBGA packages.

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 (see Figure 3). This approach allows up to 512-deep configurations as large as 16 bits wide in the smallest QuickRAM device and 44 bits wide in the largest device.

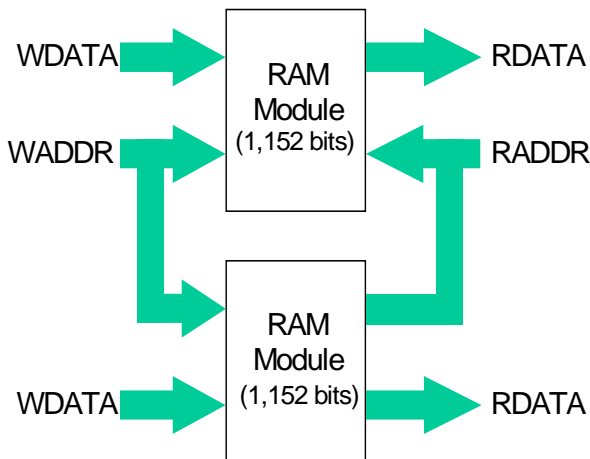




**FIGURE 2. QuickRAM Module**

Software support for the complete QuickRAM family, including the QL4016, is available through two basic packages. The turnkey QuickWorks™ package provides the most complete ESP software solution from design entry to logic synthesis, to place and route, to simulation. The QuickTools™ for Worksations package provides a solution for designers who use Cadence, Exemplar, Mentor, Syn-opsys, Synplicity, Viewlogic, Veribest, or other third-party tools for design entry, synthesis, or simulation.

The QuickLogic variable grain logic cell features up to 16 simultaneous inputs and 5 outs within a cell that can be fragmented into 5 independent cells. Each cell has a fan-in of 29 including register and control lines (see Figure 4).



**FIGURE 3. QuickRAM Module bits**

## PRODUCT SUMMARY

### Total of 252 I/O Pins

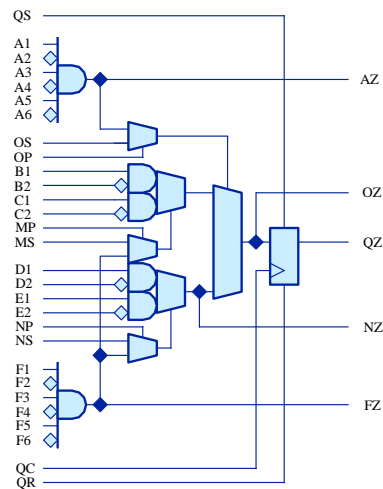
- 244 bi-directional input/output pins, PCI-compliant for 5.0 volt and 3.3 volt buses for -1/-2/-3/-4 speed grades
- 8 high-drive input/distributed network pins

### Eight Low-Skew Distributed Networks

- Two array clock/control networks available to the logic cell flip-flop clock, set and reset inputs - each driven by and input-only pin
- Six global clock/control networks available to the logic cell F1, clock, set and reset inputs and the input and I/O register clock, reset and enable inputs as well as the output enable control - each driven by an input-only or I/O pin, or any logic cell output or I/O cell feedback

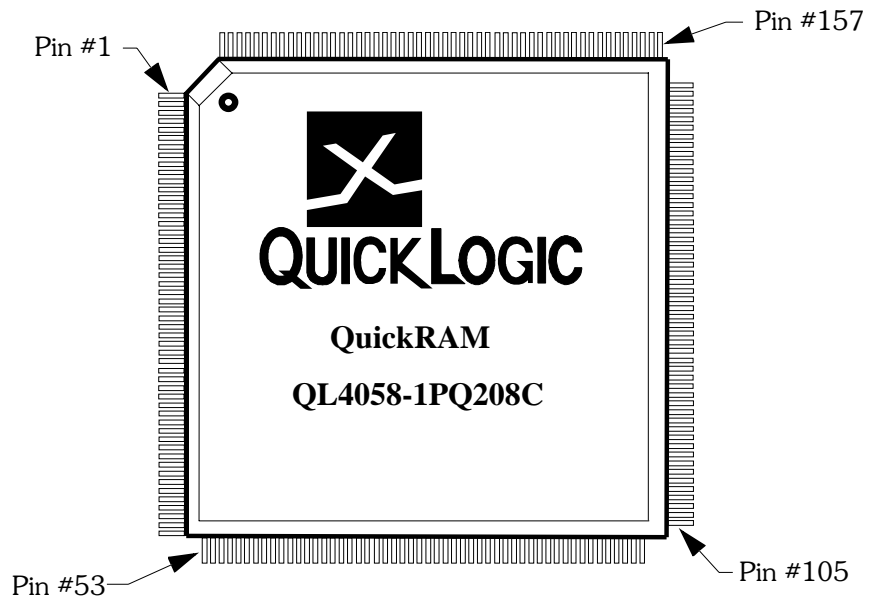
### High Performance

- Input + logic cell + output total delays under 6 ns
- Data path speeds over 400 MHz
- Counter speeds over 300 MHz
- FIFO speeds over 160+ MHz

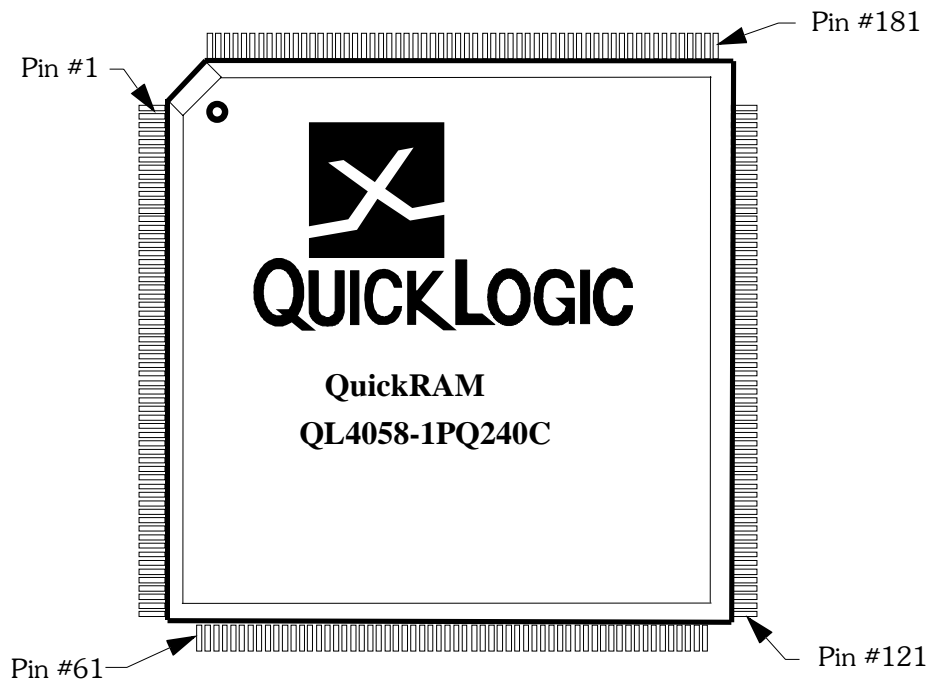


**FIGURE 4. Logic Cell**

# QL4058 - QuickRAM™



**208 Pin PQFP  
Pinout Diagram**



**240 Pin PQFP  
Pinout Diagram**

# QL4058 - QuickRAM™

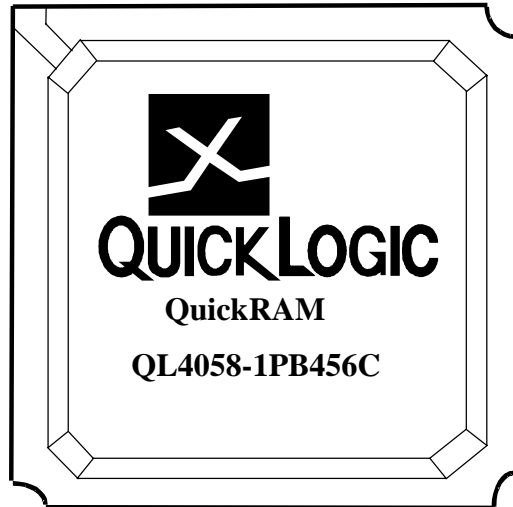
## PQFP 208/240 PINOUT TABLE

240 PQFP	208 PQFP	Function	240 PQFP	208 PQFP	Function	240 PQFP	208 PQFP	Function	240 PQFP	208 PQFP	Function	240 PQFP	208 PQFP	Function
1	208	I/O	51	43	GND	98	84	I/O	145	125	I/O	194	168	I/O
2	1	I/O	52	44	I/O	99	85	I/O	146	126	I/O	195	169	I/O
3	2	I/O	53	45	I/O	100	86	I/O	147	127	GND	196	NC	I/O
4	3	I/O	54	46	I/O	101	87	I/O	148	128	I/O	197	170	I/O
5	4	I/O	55	47	I/O	102	88	I/O	149	NC	I/O	198	171	I/O
6	5	I/O	56	48	I/O	103	89	I/O	150	129	GLCK/I	199	172	I/O
7	NC	I/O	57	NC	I/O	104	90	I/O	151	130	ACLK/I	200	173	I/O
8	6	I/O	58	49	I/O	105	91	I/O	152	131	VCC	201	174	I/O
9	7	I/O	59	50	I/O	106	92	I/O	153	132	GLCK/I	202	175	I/O
10	8	I/O	60	51	I/O	107	NC	I/O	154	133	GLCK/I	203	NC	I/O
11	9	I/O	NC	52	I/O	108	93	I/O	155	134	VCC	204	176	I/O
12	10	VCC	NC	53	I/O	109	94	I/O	156	135	I/O	205	177	GND
13	11	I/O	61	54	TDI	110	95	GND	157	136	I/O	206	178	I/O
14	12	GND	62	NC	I/O	NC	96	I/O	158	NC	I/O	207	179	I/O
15	13	I/O	63	NC	I/O	111	97	VCC	159	137	I/O	208	NC	I/O
16	14	I/O	64	55	I/O	NC	98	I/O	160	NC	GND	209	180	I/O
17	NC	I/O	65	56	I/O	NC	99	I/O	161	138	I/O	210	181	I/O
18	15	I/O	66	NC	I/O	112	100	I/O	162	139	I/O	211	182	GND
19	16	I/O	67	57	I/O	113	NC	I/O	163	140	I/O	212	NC	VCC
20	17	I/O	68	58	I/O	114	101	I/O	164	141	I/O	213	183	I/O
21	18	I/O	69	59	GND	115	NC	I/O	165	142	I/O	214	184	I/O
22	19	I/O	70	60	I/O	116	102	I/O	166	NC	I/O	215	185	I/O
23	20	I/O	71	61	VCC	117	NC	I/O	167	143	I/O	216	186	I/O
24	NC	I/O	72	62	I/O	118	NC	I/O	168	144	I/O	217	187	VCCIO
25	21	I/O	73	63	I/O	119	103	TRSTB	169	145	VCC	218	188	I/O
26	22	I/O	74	64	I/O	120	104	TMS	170	NC	I/O	219	NC	I/O
27	23	GND	75	NC	I/O	121	105	I/O	171	146	I/O	220	189	I/O
28	24	I/O	76	65	I/O	122	NC	I/O	172	147	GND	221	190	I/O
29	25	GCLK/I	77	66	I/O	123	106	I/O	173	148	I/O	222	191	I/O
30	26	ACLK/I	78	67	I/O	124	107	I/O	174	149	I/O	223	192	I/O
31	27	VCC	79	NC	I/O	125	108	I/O	175	150	I/O	224	193	I/O
32	28	GCLK/I	80	68	I/O	126	109	I/O	176	151	I/O	225	194	I/O
33	29	GCLK/I	81	69	I/O	127	NC	I/O	177	152	I/O	226	NC	I/O
34	30	VCC	82	70	I/O	128	110	I/O	178	153	I/O	227	195	I/O
35	31	I/O	83	NC	I/O	129	111	I/O	179	154	I/O	228	196	I/O
36	32	I/O	NC	71	I/O	130	112	I/O	180	155	I/O	229	197	I/O
37	NC	GND	84	NC	I/O	131	113	I/O	NC	156	I/O	230	198	I/O
38	33	I/O	85	72	I/O	132	114	VCC	181	157	TCK	231	NC	I/O
39	NC	I/O	86	73	GND	133	115	I/O	182	158	STM	232	199	GND
40	34	I/O	87	74	I/O	134	116	GND	183	NC	I/O	233	200	I/O
41	35	I/O	88	NC	VCC	135	117	I/O	184	159	I/O	234	201	VCC
42	36	I/O	89	75	I/O	136	NC	I/O	185	160	I/O	235	202	I/O
43	NC	I/O	90	76	I/O	137	118	I/O	186	161	I/O	236	203	I/O
44	37	I/O	91	77	I/O	138	119	I/O	187	162	I/O	237	204	I/O
45	38	I/O	92	78	GND	139	120	I/O	188	163	GND	238	205	I/O
46	39	I/O	93	79	I/O	140	121	I/O	189	164	I/O	239	206	I/O
47	NC	I/O	94	80	I/O	141	NC	I/O	190	165	VCC	240	207	TDO
48	40	I/O	95	81	I/O	142	122	I/O	191	166	I/O			
49	41	VCC	96	82	I/O	143	123	I/O	192	NC	I/O			
50	42	I/O	97	83	VCCIO	144	124	I/O	193	167	I/O			

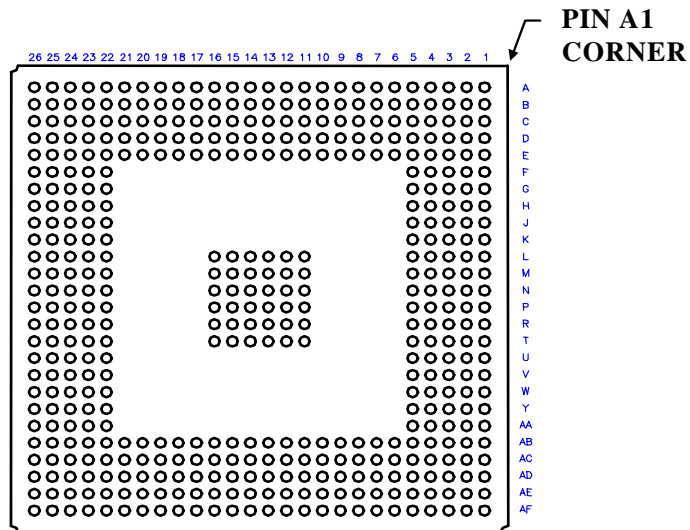
TABLE 1: PQFP 208/240 Pinout Table

# QL4058 - QuickRAM™

## PINOUT DIAGRAM



456 Pin PBGA  
TOP



Bottom

# QL4058 - QuickRAM™

## PBGA 456 PINOUT TABLE

456	Function	456	Function	456	Function	456	Function	456	Function
A1	I/O	B26	STM	D25	I/O	H4	I/O	M14	GND/THERM
A2	I/O	C1	I/O	D26	I/O	H5	NC	M15	GND/THERM
A3	I/O	C2	I/O	E1	I/O	H22	NC	M16	GND/THERM
A4	I/O	C3	I/O	E2	I/O	H23	NC	M22	NC
A5	I/O	C4	TDO	E3	I/O	H24	I/O	M23	NC
A6	I/O	C5	I/O	E4	I/O	H25	NC	M24	I/O
A7	I/O	C6	I/O	E5	GND	H26	I/O	M25	I/O
A8	I/O	C7	I/O	E6	VCC	J1	I/O	M26	I/O
A9	NC	C8	I/O	E7	GND	J2	I/O	N1	GCLK/I
A10	I/O	C9	I/O	E8	NC	J3	I/O	N2	I/O
A11	I/O	C10	I/O	E9	GND	J4	NC	N3	I/O
A12	VCCIO	C11	I/O	E10	I/O	J5	GND	N4	GCLK/I
A13	I/O	C12	I/O	E11	GND	J22	NC	N5	VCC
A14	I/O	C13	I/O	E12	GND	J23	NC	N11	GND/THERM
A15	NC	C14	I/O	E13	VCC	J24	I/O	N12	GND/THERM
A16	I/O	C15	I/O	E14	GND	J25	I/O	N13	GND/THERM
A17	NC	C16	I/O	E15	GND	J26	I/O	N14	GND/THERM
A18	I/O	C17	NC	E16	GND	K1	NC	N15	GND/THERM
A19	I/O	C18	NC	E17	NC	K2	NC	N16	GND/THERM
A20	I/O	C19	I/O	E18	GND	K3	I/O	N22	GND
A21	NC	C20	I/O	E19	NC	K4	I/O	N23	I/O
A22	I/O	C21	I/O	E20	GND	K5	VCC	N24	I/O
A23	NC	C22	I/O	E21	VCC	K22	GND	N25	NC
A24	I/O	C23	I/O	E22	GND	K23	I/O	N26	I/O
A25	I/O	C24	I/O	E23	I/O	K24	I/O	P1	I/O
A26	I/O	C25	TCK	E24	I/O	K25	NC	P2	I/O
B1	I/O	C26	NC	E25	I/O	K26	I/O	P3	NC
B2	NC	D1	I/O	E26	I/O	L1	I/O	P4	I/O
B3	I/O	D2	I/O	F1	I/O	L2	I/O	P5	NC
B4	NC	D3	I/O	F2	I/O	L3	I/O	P11	GND/THERM
B5	NC	D4	GND	F3	NC	L4	I/O	P12	GND/THERM
B6	NC	D5	NC	F4	NC	L5	NC	P13	GND/THERM
B7	NC	D6	NC	F5	VCC	L11	GND/THERM	P14	GND/THERM
B8	NC	D7	I/O	F22	VCC	L12	GND/THERM	P15	GND/THERM
B9	I/O	D8	I/O	F23	NC	L13	GND/THERM	P16	GND/THERM
B10	NC	D9	GND	F24	I/O	L14	GND/THERM	P22	NC
B11	NC	D10	I/O	F25	I/O	L15	GND/THERM	P23	GCLK / I
B12	I/O	D11	I/O	F26	I/O	L16	GND/THERM	P24	GCLK / I
B13	I/O	D12	GND	G1	I/O	L22	NC	P25	NC
B14	NC	D13	I/O	G2	I/O	L23	I/O	P26	ACLK / I
B15	I/O	D14	I/O	G3	I/O	L24	I/O	R1	NC
B16	I/O	D15	GND	G4	I/O	L25	NC	R2	I/O
B17	I/O	D16	I/O	G5	NC	L26	I/O	R3	I/O
B18	I/O	D17	I/O	G22	GND	M1	ACLK / I	R4	NC
B19	I/O	D18	GND	G23	NC	M2	GCLK/I	R5	NC
B20	I/O	D19	I/O	G24	I/O	M3	I/O	R11	GND/THERM
B21	I/O	D20	NC	G25	I/O	M4	NC	R12	GND/THERM
B22	I/O	D21	NC	G26	I/O	M5	GND	R13	GND/THERM
B23	NC	D22	I/O	H1	NC	M11	GND/THERM	R14	GND/THERM
B24	I/O	D23	GND	H2	I/O	M12	GND/THERM	R15	GND/THERM
B25	I/O	D24	I/O	H3	NC	M13	GND/THERM	R16	GND/THERM

(continued next page)

**Note: NC pins must be left unconnected on printed circuit board.**

# QL4058 - QuickRAM™

## PBGA 456 Pinout Table

(continued from previous page)

456	Function	456	Function	456	Function	456	Function
R22	VCC	Y1	NC	AC6	NC	AE5	I/O
R23	NC	Y2	I/O	AC7	NC	AE6	I/O
R24	NC	Y3	NC	AC8	NC	AE7	I/O
R25	I/O	Y4	I/O	AC9	NC	AE8	I/O
R26	GCLK / I	Y5	I/O	AC10	NC	AE9	I/O
T1	I/O	Y22	GND	AC11	I/O	AE10	I/O
T2	I/O	Y23	I/O	AC12	NC	AE11	I/O
T3	I/O	Y24	NC	AC13	I/O	AE12	I/O
T4	I/O	Y25	I/O	AC14	VCCIO	AE13	I/O
T5	VCC	Y26	I/O	AC15	NC	AE14	I/O
T11	GND/THERM	AA1	I/O	AC16	NC	AE15	I/O
T12	GND/THERM	AA2	I/O	AC17	NC	AE16	I/O
T13	GND/THERM	AA3	NC	AC18	NC	AE17	I/O
T14	GND/THERM	AA4	NC	AC19	I/O	AE18	I/O
T15	GND/THERM	AA5	VCC	AC20	I/O	AE19	I/O
T16	GND/THERM	AA22	VCC	AC21	I/O	AE20	I/O
T22	GND	AA23	NC	AC22	NC	AE21	I/O
T23	I/O	AA24	I/O	AC23	GND	AE22	NC
T24	I/O	AA25	I/O	AC24	NC	AE23	NC
T25	NC	AA26	I/O	AC25	I/O	AE24	TMS
T26	I/O	AB1	NC	AC26	I/O	AE25	I/O
U1	NC	AB2	I/O	AD1	I/O	AE26	I/O
U2	I/O	AB3	I/O	AD2	NC	AF1	I/O
U3	I/O	AB4	I/O	AD3	I/O	AF2	NC
U4	I/O	AB5	GND	AD4	I/O	AF3	I/O
U5	GND	AB6	VCC	AD5	I/O	AF4	NC
U22	NC	AB7	NC	AD6	I/O	AF5	I/O
U23	I/O	AB8	NC	AD7	I/O	AF6	I/O
U24	I/O	AB9	NC	AD8	I/O	AF7	I/O
U25	I/O	AB10	VCC	AD9	NC	AF8	I/O
U26	I/O	AB11	GND	AD10	I/O	AF9	I/O
V1	I/O	AB12	NC	AD11	NC	AF10	I/O
V2	I/O	AB13	I/O	AD12	I/O	AF11	NC
V3	NC	AB14	GND	AD13	I/O	AF12	I/O
V4	NC	AB15	VCC	AD14	I/O	AF13	I/O
V5	NC	AB16	I/O	AD15	I/O	AF14	NC
V22	GND	AB17	NC	AD16	I/O	AF15	NC
V23	NC	AB18	VCC	AD17	I/O	AF16	I/O
V24	I/O	AB19	GND	AD18	I/O	AF17	I/O
V25	NC	AB20	NC	AD19	NC	AF18	I/O
V26	I/O	AB21	VCC	AD20	NC	AF19	NC
W1	I/O	AB22	GND	AD21	I/O	AF20	I/O
W2	I/O	AB23	I/O	AD22	I/O	AF21	I/O
W3	I/O	AB24	NC	AD23	TRSTB	AF22	I/O
W4	I/O	AB25	I/O	AD24	NC	AF23	I/O
W5	NC	AB26	I/O	AD25	I/O	AF24	I/O
W22	NC	AC1	I/O	AD26	I/O	AF25	I/O
W23	I/O	AC2	I/O	AE1	TDI	AF26	I/O
W24	I/O	AC3	NC	AE2	I/O		
W25	I/O	AC4	GND	AE3	I/O		
W26	NC	AC5	NC	AE4	I/O		

Note: NC pins must be left unconnected on printed circuit board.

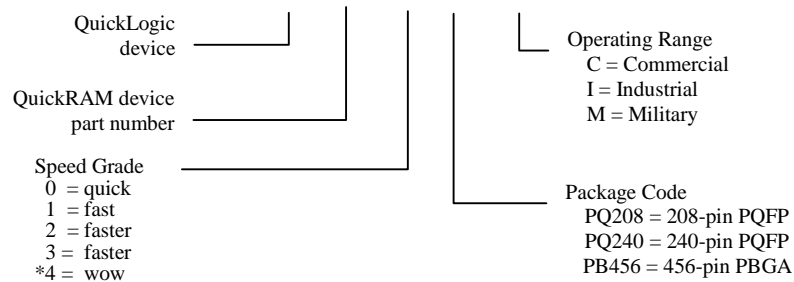
# QL4058 - QuickRAM™

## PIN DESCRIPTION

Pin	Function	Description
TDI/RSI	Test Data In for JTAG / RAM init. Serial Data In	Hold HIGH during normal operation. Connects to serial PROM data in for RAM initialization. Connect to VCC if unused.
TRSTB/RRO	Active low Reset for JTAG / RAM init. reset out	Hold LOW during normal operation. Connects to serial PROM reset for RAM initialization. Connect to GND if unused.
TMS	Test Mode Select for JTAG	Hold HIGH during normal operation. Connect to VCC if not used for JTAG.
TCK	Test Clock for JTAG	Hold HIGH or LOW during normal operation. Connect to VCC or ground if not used for JTAG.
TDO/RCO	Test data out for JTAG / RAM init. clock out	Connect to serial PROM clock for RAM initialization. Must be left unconnected if not used for JTAG or RAM initialization.
STM	Special Test Mode	Must be grounded during normal operation.
I/ACLK	High-drive input and/or array network driver	Can be configured as either or both.
I/GCLK	High-drive input and/or global network driver	Can be configured as either or both.
I	High-drive input	Use for input signals with high fanout.
I/O	Input/Output pin	Can be configured as an input and/or output.
VCC	Power supply pin	Connect to 3.3V supply.
VCCIO	Input voltage tolerance pin	Connect to 5.0 volt supply if 5 volt input tolerance is required, otherwise connect to 3.3V supply.
GND	Ground pin	Connect to ground.
GND/THERM	Ground/Thermal pin	Available on 456-PBGA only. Connect to ground plane on PCB if heat sinking desired. Otherwise may be left unconnected.

## Ordering Information

### QL 4058 - 1 PQ208 C



\* Contact QuickLogic regarding availability.



# QL4058 - QuickRAM™

## 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 +150°C
Latch-up Immunity .....	±200mA	Lead Temperature .....	300°C

## Operating Range

Symbol	Parameter	Military		Industrial		Commercial		Unit	
		Min	Max	Min	Max	Min	Max		
VCC	Supply Voltage	3.0	3.6	3.0	3.6	3.0	3.6	V	
VCCIO	I/O Input Tolerance Voltage	3.0	5.5	3.0	5.5	3.0	5.25	V	
TA	Ambient Temperature	-55		-40	85	0	70	°C	
TC	Case Temperature		125					°C	
K	Delay Factor	-0 Speed Grade	0.42	2.03	0.43	1.90	0.46	1.85	
		-1 Speed Grade	0.42	1.64	0.43	1.54	0.46	1.50	
		-2 Speed Grade	0.42	1.37	0.43	1.28	0.46	1.25	
		-3 Speed Grade	N/A	N/A	0.43	0.90	0.46	0.88	
		-4 Speed Grade	N/A	N/A	0.43	0.82	0.46	0.80	

## 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 [1]		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 [2]			10	pF
IOS	Output Short Circuit Current [3]	VO = GND	-15	-180	mA
		VO = VCC	40	210	mA
ICC	D.C. Supply Current [4]	VI, VIO = VCCIO or GND	0.50 (typ)	2	mA
ICCIO	D.C. Supply Current on VCCIO		0	100	µA

Notes:

[1] Applies only to -1/-2/-3/-4 commercial grade devices. These speed grades are also PCI-compliant. All other devices have 8 mA IOL specifications.

[2]Capacitance is sample tested only. Clock pins are 12 pF maximum.

[3]Only one output at a time. Duration should not exceed 30 seconds.

[4]For -1/-2/-3/-4 commercial grade devices only. Maximum ICC is 3 mA for -0 commercial grade and all industrial grade devices, and 5 mA for all military grade devices. For AC conditions, contact QuickLogic customer engineering.

## 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) [5]	5.0	5.3	5.6	5.9	7.1

Notes:

[5] 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.

[6] 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 [5]	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 [5]	3.0	3.3	3.6	3.9	5.1

## Input-Only/Clock 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:

[7]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.

## I/O Cell Input Delays

Symbol	Parameter	Propagation Delays (ns) Fanout [5]					
		1	2	3	4	8	10
tl/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
TOUTH	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:

[8]The following loads are used for tPXZ

