

# Military QuickRAM



**90,000 Usable PLD Gate QuickRAM Combining Performance, Density and Embedded RAM**

## DEVICE HIGHLIGHTS

### High Performance and High Density

- Up to 90,000 Usable PLD Gates with 316 I/Os
- 300 MHz 16-bit Counters, 400 MHz Datapaths, 160+ MHz FIFOs
- 0.35um four-layer metal non-volatile CMOS process for smallest die sizes

### High Speed Embedded SRAM

- Up to 22 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 buses for -1/-2 speed grades
- Full JTAG boundary scan
- Registered I/O cells with individually controlled clocks and output enables

## FEATURES

### Total of 316 I/O pins

- 308 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 an 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 exceeding 400 MHz
- Counter speeds over 300 MHz
- FIFO speeds over 160+ MHz

### Military Reliability

- Mil-STD-883 and Mil Temp Ceramic
- Mil Temp Plastic - Guaranteed -55°C to 125°C

Device	Usable Gates	Package	Max I/O	Qualification Level	Supply Voltage
QL4016 11,520 RAM Bits	8,000-16,000	84CPGA	70	M, /883	3.3 V
		84PLCC	70	M	3.3 V
		100CQFP	82	M, /883	3.3 V
QL4036 16,128 RAM bits	16,000-25,000	144CPGA	118	M, /883	3.3 V
		208PQFP	174	M	3.3 V
		208CQFP	174	M, /883	3.3 V
QL4090 25,344 RAM bits	36,000-60,000	208PQFP	174	M	3.3V
		208CQFP	174	M, /883	3.3V
		240PQFP	207	M	3.3V
		256CPGA	223	M, /883	3.3V
		456PBGA	316	M	3.3V

M = Military Temperature (-15 to +125 degrees C)  
/888 = MIL STD 883

TABLE 1: Selector Table

# Military QuickRAM

## PRODUCT SUMMARY

The QuickRAM family of ESPs (Embedded Standard Products) offers FPGA logic in combination with Dual-Port SRAM modules. QuickRAM is a 90,000 usable PLD gate ESPs. QuickRAM ESPs are fabricated on a 0.35mm 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.

QuickRAM contains up to 1,584 logic cells and 22 dual port RAM modules. Each RAM module has 1,152 RAM bits, for a total of up to 25,344 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. With a maximum of 316 I/Os, and is avail-

able in plastic 84-PLCC, 208-PQFP, 240-PQFP and 456-PBGA packages and in ceramic 100, 208-CQFP and 84, 144, 256-CPGA.

Software support for the complete QuickRAM family 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 Workstations package provides a solution for designers who use Cadence, Exemplar, Mentor, Synopsys, Synplicity, Viewlogic, Veribest, or other third-party tools for design entry, synthesis, or simulation.

## PINOUT DIAGRAM 84-PIN PLCC

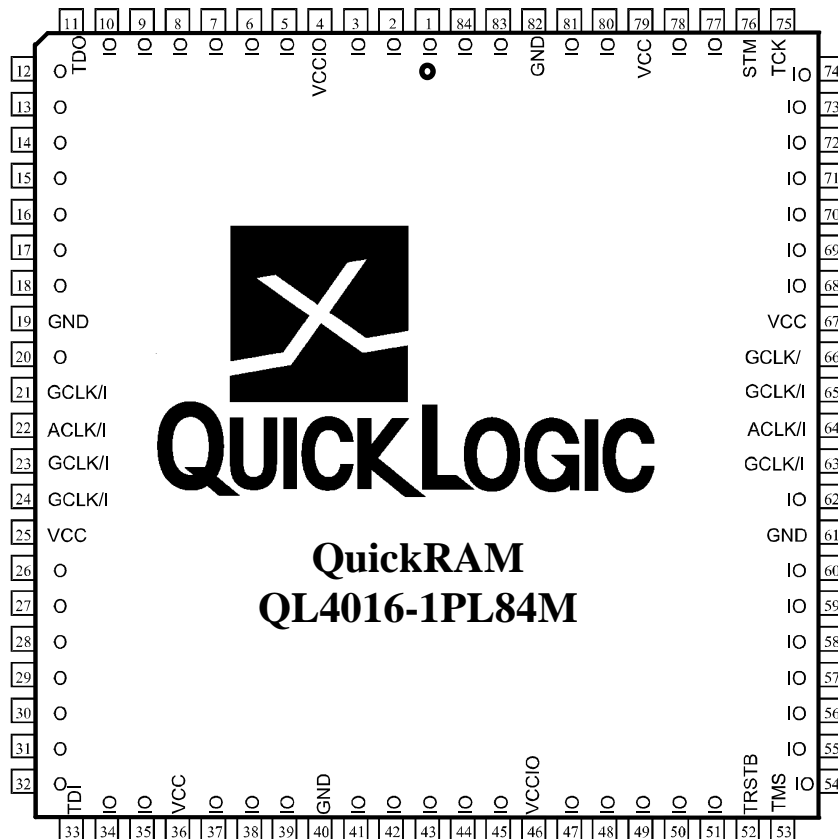


TABLE 2: 84-pin PLCC

# Military QuickRAM

## PINOUT DIAGRAM 100-PIN CQFP



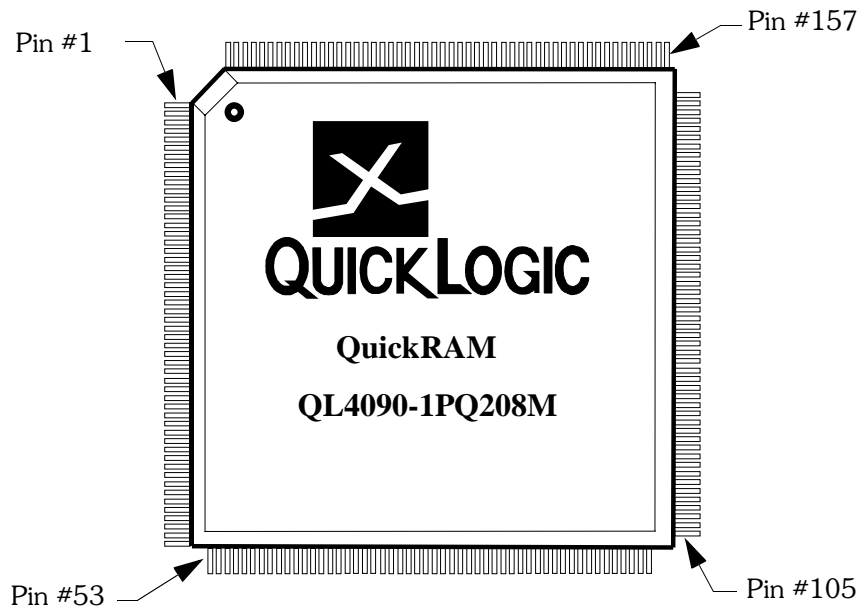
100 CQFP Pinout Table

100 TQFP	Function	100 TQFP	Function	100 TQFP	Function	100 TQFP	Function
1	I/O	26	TDI	51	I/O	76	TCK
2	I/O	27	I/O	52	I/O	77	STM
3	I/O	28	I/O	53	I/O	78	I/O
4	I/O	29	I/O	54	I/O	79	I/O
5	I/O	30	I/O	55	I/O	80	I/O
6	I/O	31	I/O	56	I/O	81	I/O
7	I/O	32	I/O	57	I/O	82	I/O
8	I/O	33	I/O	58	I/O	83	I/O
9	GND	34	I/O	59	GND	84	I/O
10	I/O	35	GND	60	I/O	85	GND
11	GCLK / I	36	I/O	61	GCLK / I	86	I/O
12	ACLK / I	37	I/O	62	ACLK / I	87	I/O
13	VCC	38	GND	63	VCC	88	GND
14	GCLK / I	39	I/O	64	GCLK / I	89	I/O
15	GCLK / I	40	I/O	65	GCLK / I	90	I/O
16	VCC	41	I/O	66	VCC	91	I/O
17	I/O	42	VCCIO	67	I/O	92	VCCIO
18	I/O	43	I/O	68	I/O	93	I/O
19	I/O	44	I/O	69	I/O	94	I/O
20	I/O	45	I/O	70	I/O	95	I/O
21	I/O	46	I/O	71	I/O	96	I/O
22	I/O	47	I/O	72	I/O	97	I/O
23	I/O	48	I/O	73	I/O	98	I/O
24	I/O	49	TRSTB	74	I/O	99	I/O
25	I/O	50	TMS	75	I/O	100	TDO

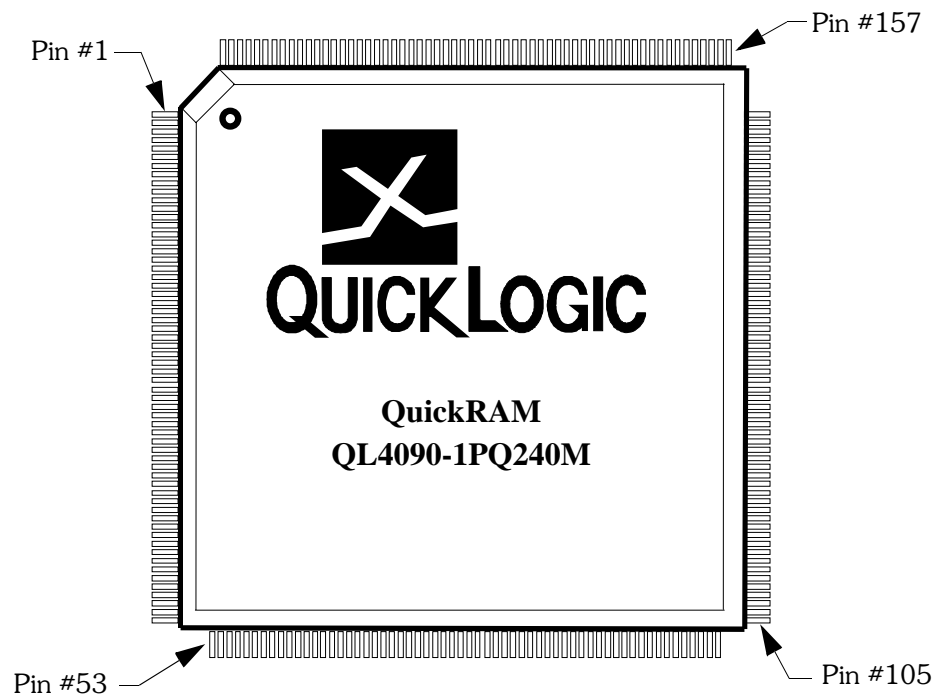
# Military QuickRAM

## PINOUT DIAGRAMS

### 208-Pin PQFP/CQFP



### 240-Pin PQFP



# Military QuickRAM

## PINOUT TABLE

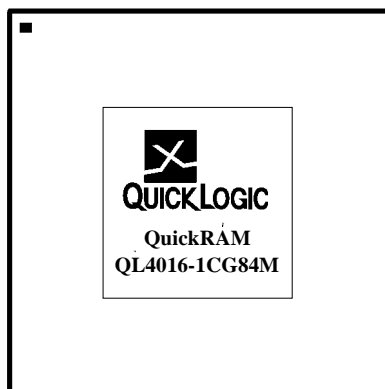
### PQFP/CQFP 240/208 Pinout Table

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	GCLK / 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	GCLK / I	202	175	I/O
10	8	I/O	60	51	I/O	107	NC	I/O	154	133	GCLK / 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			

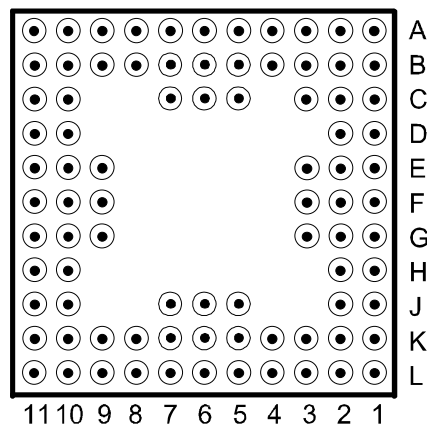
# Military QuickRAM

## PINOUT DIAGRAM 84-PIN CPGA

TOP VIEW



BOTTOM VIEW



84-Pin CPGA Pinout Table

84 CPGA	Function	84 CPGA	Function	84 CPGA	Function	84 CPGA	Function
A1	I/O	B11	I/O	F9	I/O	K2	I/O
A2	I/O	C1	VCC	F10	I/O	K3	I/O
A3	I/O	C2	I/O	F11	I/O	K4	I/O
A4	I/O	C5	VCC	G1	I/O	K5	GCLK / I
A5	I/O	C6	ACLK / I	G2	I/O	K6	GCLK / I
A6	I/O	C7	GND	G3	VCCIO	K7	GCLK / I
A7	I/O	C10	I/O	G9	GND	K8	I/O
A8	I/O	C11	I/O	G10	I/O	K9	I/O
A9	I/O	D1	I/O	G11	I/O	K10	TCK
A10	I/O	D2	I/O	H1	I/O	K11	I/O
A11	TDO	D10	I/O	H2	I/O	L1	TMS
B1	I/O	D11	I/O	H10	VCC	L2	I/O
B2	TDI	E1	I/O	H11	I/O	L3	I/O
B3	I/O	E2	I/O	J1	I/O	L4	I/O
B4	I/O	E3	GND	J2	TRSTB	L5	I/O
B5	GCLK / I	E9	VCCIO	J5	GND	L6	I/O
B6	GCLK / I	E10	I/O	J6	ACLK / I	L7	I/O
B7	GCLK / I	E11	I/O	J7	VCC	L8	I/O
B8	I/O	F1	I/O	J10	STM	L9	I/O
B9	I/O	F2	I/O	J11	I/O	L10	I/O
B10	I/O	F3	I/O	K1	I/O	L11	I/O

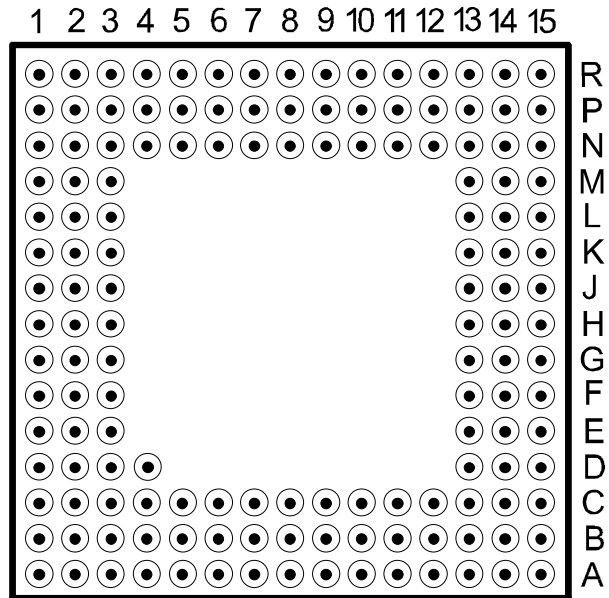
# Military QuickRAM

## PINOUT DIAGRAMS 144 & 256-PIN CPGAs

TOP VIEW

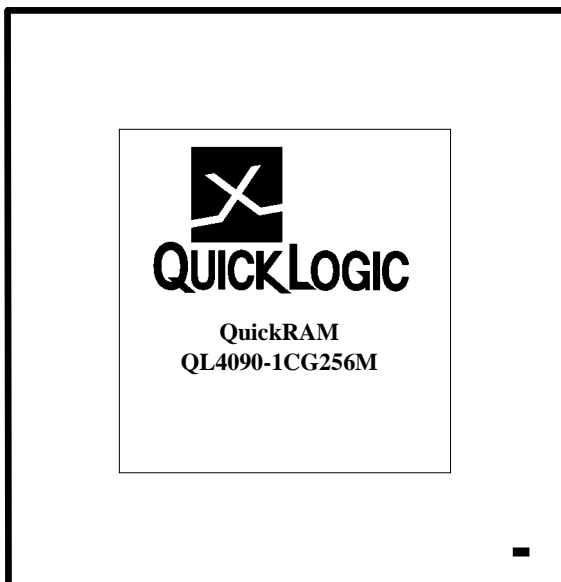


BOTTOM VIEW

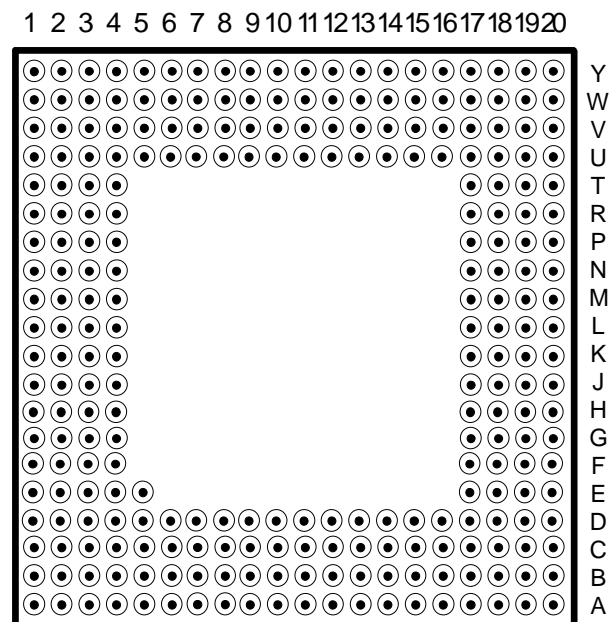


144-Pin CPGA

TOP VIEW



BOTTOM VIEW



256-Pin CPGA

# Military QuickRAM

## PINOUT TABLE 144-PIN CPGA

144 CPGA	Function	144 CPGA	Function	144 CPGA	Function	144 CPGA	Function
A1	I/O	C7	I/O	H13	ACLK / I	N10	I/O
A2	I/O	C8	GND	H14	I/O	N11	GND
A3	I/O	C9	I/O	H15	GCLK / I	N12	I/O
A4	I/O	C10	I/O	J1	GCLK / I	N13	I/O
A5	I/O	C11	I/O	J2	VCC	N14	I/O
A6	I/O	C12	TCK	J3	VCC	N15	I/O
A7	I/O	C13	I/O	J13	I/O	P1	I/O
A8	I/O	C14	I/O	J14	I/O	P2	I/O
A9	I/O	C15	I/O	J15	GND	P3	TDI
A10	GND	D1	I/O	K1	GCLK / I	P4	I/O
A11	I/O	D2	I/O	K2	I/O	P5	I/O
A12	I/O	D3	I/O	K3	I/O	P6	I/O
A13	VCC	D13	I/O	K13	I/O	P7	I/O
A14	I/O	D14	I/O	K14	I/O	P8	I/O
A15	I/O	D15	I/O	K15	I/O	P9	VCCIO
B1	I/O	E1	I/O	L1	I/O	P10	I/O
B2	TDO	E2	VCC	L2	I/O	P11	I/O
B3	I/O	E3	I/O	L3	GND	P12	I/O
B4	I/O	E13	GND	L13	I/O	P13	I/O
B5	I/O	E14	I/O	L14	VCC	P14	TRSTB
B6	I/O	E15	I/O	L15	I/O	P15	I/O
B7	VCCIO	F1	I/O	M1	I/O	R1	I/O
B8	I/O	F2	I/O	M2	I/O	R2	I/O
B9	I/O	F3	I/O	M3	I/O	R3	VCC
B10	I/O	F13	I/O	M13	I/O	R4	I/O
B11	I/O	F14	I/O	M14	I/O	R5	I/O
B12	I/O	F15	GCLK / I	M15	I/O	R6	GND
B13	STM	G1	GND	N1	I/O	R7	I/O
B14	I/O	G2	I/O	N2	I/O	R8	I/O
B15	I/O	G3	I/O	N3	I/O	R9	I/O
C1	I/O	G13	VCC	N4	I/O	R10	I/O
C2	I/O	G14	VCC	N5	I/O	R11	I/O
C3	I/O	G15	GCLK / I	N6	I/O	R12	I/O
C4	I/O	H1	GCLK / I	N7	I/O	R13	I/O
C5	GND	H2	I/O	N8	GND	R14	I/O
C6	I/O	H3	ACLK / I	N9	I/O	R15	TMS



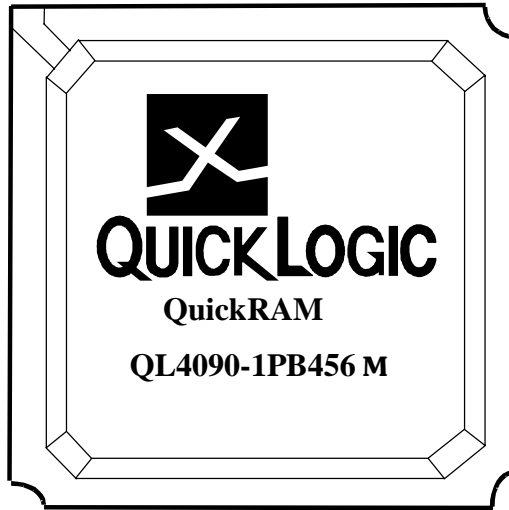
# Military QuickRAM

## PINOUT TABLE 256-PIN CPGA

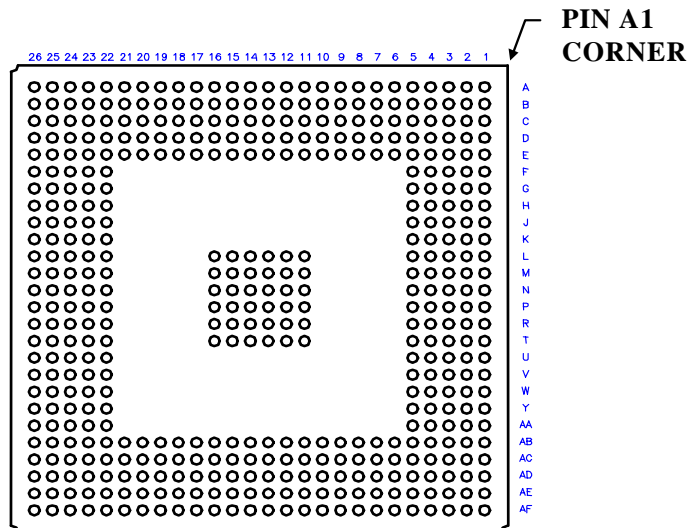
256 CPGA	Function	256 CPGA	Function	256 CPGA	Function	256 CPGA	Function	256 CPGA	Function	256 CPGA	Function
A1	VCC	C4	I/O	E19	I/O	L2	GCLK / I	T17	I/O	V20	I/O
A2	I/O	C5	I/O	E20	VCC	L3	GND	T18	I/O	W1	I/O
A3	VCC	C6	I/O	F1	I/O	L4	I/O	T19	I/O	W2	I/O
A4	I/O	C7	I/O	F2	GND	L17	GCLK / I	T20	I/O	W3	I/O
A5	I/O	C8	I/O	F3	I/O	L18	I/O	U1	I/O	W4	I/O
A6	I/O	C9	I/O	F4	I/O	L19	VCC	U2	I/O	W5	GND
A7	I/O	C10	I/O	F17	I/O	L20	ACLK / I	U3	I/O	W6	I/O
A8	I/O	C11	VCC	F18	GND	M1	VCC	U4	I/O	W7	I/O
A9	I/O	C12	I/O	F19	I/O	M2	I/O	U5	I/O	W8	I/O
A10	GND	C13	I/O	F20	I/O	M3	I/O	U6	I/O	W9	I/O
A11	I/O	C14	I/O	G1	I/O	M4	I/O	U7	I/O	W10	I/O
A12	I/O	C15	I/O	G2	I/O	M17	I/O	U8	I/O	W11	GND
A13	I/O	C16	I/O	G3	I/O	M18	I/O	U9	I/O	W12	I/O
A14	I/O	C17	I/O	G4	I/O	M19	I/O	U10	VCC	W13	VCCIO
A15	I/O	C18	I/O	G17	I/O	M20	I/O	U11	I/O	W14	I/O
A16	I/O	C19	I/O	G18	I/O	N1	I/O	U12	I/O	W15	I/O
A17	I/O	C20	I/O	G19	I/O	N2	I/O	U13	I/O	W16	I/O
A18	GND	D1	VCC	G20	I/O	N3	I/O	U14	I/O	W17	I/O
A19	I/O	D2	I/O	H1	I/O	N4	I/O	U15	I/O	W18	I/O
A20	TCK	D3	I/O	H2	I/O	N17	I/O	U16	I/O	W19	TRSTB
B1	I/O	D4	I/O	H3	I/O	N18	I/O	U17	I/O	W20	I/O
B2	I/O	D5	I/O	H4	I/O	N19	I/O	U18	I/O	Y1	TDI
B3	I/O	D6	I/O	H17	I/O	N20	GND	U19	I/O	Y2	I/O
B4	GND	D7	I/O	H18	I/O	P1	I/O	U20	I/O	Y3	I/O
B5	I/O	D8	I/O	H19	I/O	P2	I/O	V1	I/O	Y4	VCC
B6	I/O	D9	I/O	H20	I/O	P3	VCC	V2	I/O	Y5	I/O
B7	I/O	D10	I/O	J1	I/O	P4	I/O	V3	I/O	Y6	I/O
B8	VCCIO	D11	I/O	J2	I/O	P17	GND	V4	I/O	Y7	I/O
B9	I/O	D12	I/O	J3	GND	P18	I/O	V5	I/O	Y8	I/O
B10	VCC	D13	I/O	J4	I/O	P19	I/O	V6	I/O	Y9	I/O
B11	I/O	D14	I/O	J17	I/O	P20	I/O	V7	I/O	Y10	I/O
B12	GND	D15	I/O	J18	VCC	R1	I/O	V8	I/O	Y11	I/O
B13	I/O	D16	I/O	J19	GND	R2	I/O	V9	VCC	Y12	I/O
B14	I/O	D17	STM	J20	VCC	R3	GND	V10	GND	Y13	I/O
B15	I/O	D18	I/O	K1	ACLK / I	R4	I/O	V11	I/O	Y14	I/O
B16	VCC	D19	I/O	K2	VCC	R17	I/O	V12	I/O	Y15	I/O
B17	I/O	D20	I/O	K3	GND	R18	VCC	V13	I/O	Y16	I/O
B18	GND	E1	I/O	K4	GCLK / I	R19	I/O	V14	I/O	Y17	VCC
B19	I/O	E2	I/O	K17	I/O	R20	I/O	V15	GND	Y18	I/O
B20	I/O	E3	I/O	K18	I/O	T1	I/O	V16	I/O	Y19	I/O
C1	I/O	E4	I/O	K19	GCLK / I	T2	I/O	V17	GND	Y20	I/O
C2	I/O	E17	I/O	K20	GCLK / I	T3	I/O	V18	TMS		
C3	TDO	E18	I/O	L1	GCLK / I	T4	VCC	V19	I/O		

# Military QuickRAM

## PINOUT DIAGRAM 456-PIN PBGA



456 Pin PBGA  
TOP



Bottom

# Military QuickRAM

## PINOUT TABLE 456-PIN PBGA

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	I/O	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	I/O	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	I/O	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	I/O	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	I/O	C16	I/O	E15	GND	J26	I/O	N14	GND/THERM
A18	I/O	C17	I/O	E16	GND	K1	I/O	N15	GND/THERM
A19	I/O	C18	I/O	E17	NC	K2	I/O	N16	GND/THERM
A20	I/O	C19	I/O	E18	GND	K3	I/O	N22	GND
A21	I/O	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	I/O	C22	I/O	E21	VCC	K22	GND	N25	I/O
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	I/O	P2	I/O
B1	I/O	C26	I/O	E25	I/O	K26	I/O	P3	I/O
B2	I/O	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	I/O	D3	I/O	F2	I/O	L3	I/O	P11	GND/THERM
B5	I/O	D4	GND	F3	I/O	L4	I/O	P12	GND/THERM
B6	I/O	D5	I/O	F4	NC	L5	NC	P13	GND/THERM
B7	I/O	D6	NC	F5	VCC	L11	GND/THERM	P14	GND/THERM
B8	I/O	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	I/O	D9	GND	F24	I/O	L14	GND/THERM	P22	NC
B11	I/O	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	I/O
B14	I/O	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	I/O
B16	I/O	D15	GND	G4	I/O	L25	I/O	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	I/O	M2	GCLK/I	R5	NC
B20	I/O	D19	I/O	G24	I/O	M3	I/O	R11	GND/THERM
B21	I/O	D20	I/O	G25	I/O	M4	NC	R12	GND/THERM
B22	I/O	D21	NC	G26	I/O	M5	GND	R13	GND/THERM
B23	I/O	D22	I/O	H1	I/O	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	I/O	M13	GND/THERM	R16	GND/THERM

(Cont'd on next page)

# Military QuickRAM

## PBGA 456 Pinout Table

(continued from previous page)

456	Function	456	Function	456	Function	456	Function
R22	VCC	Y1	I/O	AC6	NC	AE5	I/O
R23	NC	Y2	I/O	AC7	I/O	AE6	I/O
R24	I/O	Y3	I/O	AC8	I/O	AE7	I/O
R25	I/O	Y4	I/O	AC9	NC	AE8	I/O
R26	GCLK / I	Y5	I/O	AC10	I/O	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	I/O	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/THERMAL	AA1	I/O	AC16	I/O	AE15	I/O
T12	GND/THERMAL	AA2	I/O	AC17	I/O	AE16	I/O
T13	GND/THERMAL	AA3	NC	AC18	NC	AE17	I/O
T14	GND/THERMAL	AA4	NC	AC19	I/O	AE18	I/O
T15	GND/THERMAL	AA5	VCC	AC20	I/O	AE19	I/O
T16	GND/THERMAL	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	I/O
T24	I/O	AA25	I/O	AC24	I/O	AE23	NC
T25	I/O	AA26	I/O	AC25	I/O	AE24	TMS
T26	I/O	AB1	I/O	AC26	I/O	AE25	I/O
U1	I/O	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	I/O
U4	I/O	AB5	GND	AD4	I/O	AF3	I/O
U5	GND	AB6	VCC	AD5	I/O	AF4	I/O
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	I/O	AF8	I/O
U26	I/O	AB11	GND	AD10	I/O	AF9	I/O
V1	I/O	AB12	NC	AD11	I/O	AF10	I/O
V2	I/O	AB13	I/O	AD12	I/O	AF11	I/O
V3	I/O	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	I/O
V22	GND	AB17	NC	AD16	I/O	AF15	I/O
V23	NC	AB18	VCC	AD17	I/O	AF16	I/O
V24	I/O	AB19	GND	AD18	I/O	AF17	I/O
V25	I/O	AB20	NC	AD19	I/O	AF18	I/O
V26	I/O	AB21	VCC	AD20	I/O	AF19	I/O
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	I/O	AD23	TRSTB	AF22	I/O
W4	I/O	AB25	I/O	AD24	I/O	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	I/O	AC5	I/O	AE4	I/O		

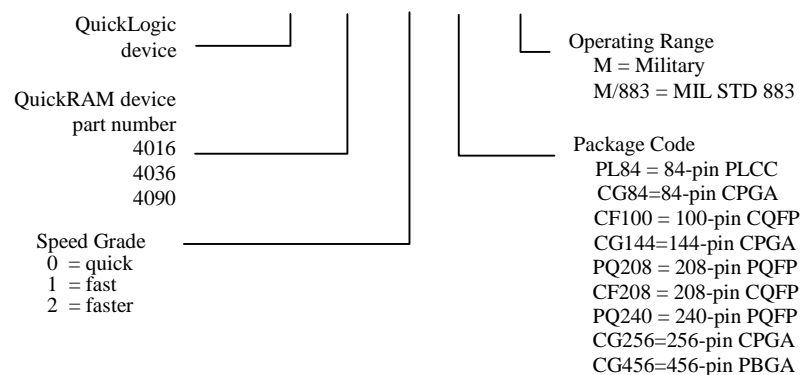
# Military QuickRAM

## PIN DESCRIPTIONS

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 4090 - 1 PQ208 M



# Military 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 .....	±200 mA	Lead Temperature .....	300°C

## OPERATING RANGE

Symbol	Parameter	Military		Unit	
		Min	Max		
VCC	Supply Voltage	3.0	3.6	V	
VCCIO	I/O Input Tolerance Voltage	3.0	5.5	V	
TA	Ambient Temperature	-55		°C	
TC	Case Temperature		125	°C	
K	Delay Factor	-0 Speed Grade	0.42	2.03	
		-1 Speed Grade	0.42	1.64	
		-2 Speed Grade	0.42	1.37	

## 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 = 8 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)	5	mA
ICCIO	D.C. Supply Current on VCCIO		0	100	µA

Notes:

- [1] Military 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] Maximum ICC is 5 mA for all military grade devices. For AC conditions, contact QuickLogic customer engineering.

# Military QuickRAM

## QL4016

### 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 [6]				
		1	2	3	4	8
tPD	Combinatorial Delay [7]	1.4	1.7	1.9	2.2	3.2
tSU	Setup Time [7]	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

#### Input-Only/Clock Cells

Symbol	Parameter	Propagation Delays (ns) Fanout [6]						
		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

Notes:

- [6] 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.
- [7] 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.

# Military QuickRAM

## QL4016 Clock Cells

Symbol	Parameter	Propagation Delays (ns) Loads per Half Column [8]						
		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

## I/O Cell Input Delays

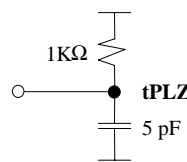
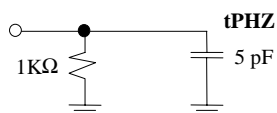
Symbol	Parameter	Propagation Delays (ns) Fanout [6]						
		1	2	3	4	8	10	
tl/O	Input Delay (bidirectional pad)	1.3	1.6	1.8	2.1	3.1	3.6	
TISU	Input Register Set-Up Time	3.1	3.1	3.1	3.1	3.1	3.1	
TIH	Input Register Hold Time	0.0	0.0	0.0	0.0	0.0	0.0	
TIOCLK	Input Register Clock To Q	0.7	1.0	1.2	1.5	2.5	3.0	
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 [9]	2.0				
TPLZ	Output Delay Low to Tri-State [9]	1.2				

Notes:

- [6] 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.
- [8] 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.
- [9] The following loads are used for tPXZ:





# Military QuickRAM

## QL4036

### 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

#### 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

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 pASIC 3 logic cell including typical net delays. Worst case delay values for specific paths should be determined from timing analysis of your particular design.

# Military QuickRAM

## QL4036 Clock Cells

Symbol	Parameter	Propagation Delays (ns) Loads per Half Column [7]							
		1	2	3	4	8	10	12	15
tACK	Array Clock Delay	1.2	1.2	1.3	1.3	1.5	1.6	1.7	1.8
tGCKP	Global Clock Pin Delay	0.7	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	1.4

## I/O Cell Input Delays

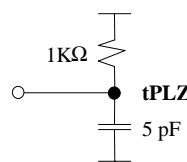
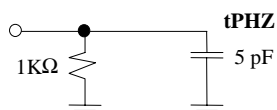
Symbol	Parameter	Propagation Delays (ns) Fanout [5]					
		1	2	3	4	8	10
tI/O	Input Delay (bidirectional pad)	1.3	1.6	1.8	2.1	3.1	3.6
TISU	Input Register Set-Up Time	3.1	3.1	3.1	3.1	3.1	3.1
TIH	Input Register Hold Time	0.0	0.0	0.0	0.0	0.0	0.0
TIOCLK	Input Register Clock To Q	0.7	1.0	1.2	1.5	2.5	3.0
TIORST	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
TOUHL	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:

- [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.
- [7] The array distributed networks consist of 56 half columns and the global distributed networks consist of 60 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 12 loads per half column. The global clock has up to 15 loads per half column.
- [8] The following loads are used for tPXZ:



# Military QuickRAM

## QL4090

### 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

#### 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

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 pASIC 3 logic cell including typical net delays. Worst case delay values for specific paths should be determined from timing analysis of your particular design.

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## QL4090 Clock Cells

Symbol	Parameter	Propagation Delays (ns) Loads per Half Column [7]										
		1	2	3	4	8	10	12	14	16	18	20
TACK	Array Clock Delay	1.2	1.2	1.3	1.3	1.5	1.6	1.7	1.8	1.9	2	2.1
TGCKP	Global Clock Pin Delay	0.7	0.7	0.7	0.7	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	1.4	1.5	1.6	1.7

## I/O Cell Input Delays

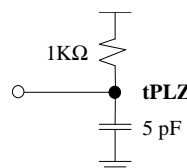
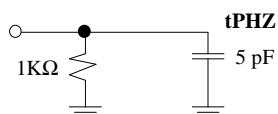
Symbol	Parameter	Propagation Delays (ns) Fanout [5]					
		1	2	3	4	8	10
tI/O	Input Delay (bidirectional pad)	1.3	1.6	1.8	2.1	3.1	3.6
TISU	Input Register Set-Up Time	3.1	3.1	3.1	3.1	3.1	3.1
TIH	Input Register Hold Time	0.0	0.0	0.0	0.0	0.0	0.0
TIOCLK	Input Register Clock To Q	0.7	1.0	1.2	1.5	2.5	3.0
TIORST	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:

- [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.
- [7] The array distributed networks consist of 88 half columns and the global distributed networks consist of 92 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 18 loads per half column. The global clock has up to 20 loads per half column.
- [8] The following loads are used for tPXZ:



# Military QuickRAM

## 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

## 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

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.

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